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Foreword

Technical reports and letter reports published by the United States Army Aeromedical Research Laboratory (USAARL) from June 1963 through September 1987 are included in this annotated bibliography, volume 1, of reports, this edition dated May 1991. The number listed in italics following the month of publication is the Order number from the Defense Technical Information Center.

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This annotated bibliography does not include special reports, papers, articles published in professional or technical journals, proceedings, etc.

Table of contents

Listing of letter reports by title and author(s) *(Continued)*

Section A

Listing of technical reports

by title and author(s) with abstracts.

Report number	Title, author(s), and abstract

Fiscal Year 1963

63- 1. **Noise problems associated with the operation of U.S. Army aircraft.** June 1963. *(ADA421567)*

By Jimmy L. Hatfield and Donald C. Gasaway.

This report describes and illustrates basic, as well as unique, characteristics of noise associated with the operation of Army aircraft. It summarizes the important facts relative to hazardous noise, its effects on man, the characteristics of noise generators, noise reduction concepts, and future noise problems. The purpose is to alert aviation medical officers, flight surgeons, and physicians in the Army to this problem, and provide guidance in those circumstances where a problem of potentially hazardous noise exists.

Fiscal Year 1964

64- 1. **A survey of internal and external noise environments in U.S. aircraft.** December 1963. *(ADA428331)*

By Jimmy L. Hatfield and Donald C. Gasaway.

This report presents and describes representative internal and external noise environments for each major type of Army aircraft during normal operations. Measurements of all fixed- and rotary-wing aircraft are classified, when appropriate, into four major categories: Ground operations, hovering flight, normal, and maximum cruise conditions. The contributions of major noise generators in each type of aircraft is discussed in detail.

Fiscal Year 1965

65- 1. **Air drop of ACD whole blood.** July 1964. *(ADA444330)*

By Charles I. Wabner.

To evaluate the effects of air drop on ACD whole blood as a relation to the plasma hemoglobin levels before and after drop. Nineteen percent of the units of blood dropped were fractured and unusable due to impact shock. Those units re-

maining intact showed no significant elevation in plasma hemoglobin. Present methods of packaging blood for aerial drops are inadequate. Erythrocyte breakdown due to impact forces is not significant.

65- 2. **Color vision deficiencies in Army fliers.** April 1965. *(ADA462860)*

By Robert W. Bailey.

Normal color vision has historically been an intrinsic part of the physical standards maintained for military and civilian aviators and aircrew members. This a priori requirement has not been challenged due to the abundant number of applicants versus the number of such positions available. There is no longer a surplus of such personnel.

In view of the percentage of the male population affected by imperfect color vision, this standard contributes significantly to the number of applicants rejected. An easement of this standard could be immediately converted to a large number of otherwise qualified applicants. This paper deals with a review of some color tests and a testing procedure employed to determine the number of color-anomalous fliers in Army aviation. Data collected indicated that this requirement may be unnecessary and that a new philosophical approach is long overdue.

65- 3. **Noise spectra of the Bell OH-13-T helicopter.** May 1965. *(ADA465115)*

By Robert T. Camp, Jr.

Overall sound pressure levels were measured and an octave band analysis was made of the internal and external noise of the Bell OH-13-T helicopter. The results of the tests show that the noise level in the OH-13-T is not considered to be significantly different than the levels that have been recorded in the OH-13-H helicopter. Earplugs and efficient ear-muffs or helmets will attenuate the noise to levels that are considered to be safe for operations of long duration.

65- 4. **Noise spectra of the Turbo-Beaver.** May 1965. *(ADA465116)*

By Robert T. Camp, Jr., and Robert W. Bailey.

Sound pressure levels were measured in various positions inside the Turbo-Beaver under various power conditions. A comparison of these data with comparable available data taken from measurements of sound pressure levels in the U-6A

shows that the overall level and the lower portion of the spectrum in the U-6A had higher sound pressure levels. The octave bands of the Turbo-Beaver's noise spectrum, above the band centered around 500 cps, had higher sound pressure levels.

Fiscal Year 1966

66- 1. **Preliminary carbon monoxide measurements in armed helicopters.** March 1966. *(ADA479896L)*

By G. L. Hody, Jr., and William P. Schane.

The atmospheric concentration of carbon monoxide was measured in the cabins of UH-1B and CH-47A helicopters during weapons firing. These measurements are of interest not only because of the high toxicity of carbon monoxide, but also as an indication of significant cabin air contamination with weapons exhaust (which contains a high concentration of carbon monoxide).

Concentrations of carbon monoxide as high as 1000 PPM (0.1 percent) were noted to persist as long as 60 seconds after the firing of certain weapons. Subjective respiratory symptoms also were noted. These findings point out the need for determination of weapons exhaust composition and development of suitable analytical methods of measuring carbon monoxide in test helicopters. The development of rugged, sensitive instruments with rapid response is needed. Additional consultation, as well as laboratory research, is planned.

66- 2. **Evaluation of two vibration insensitive catalytic detectors for carbon monoxide.** March 1966. *(ADA479882L)*

By G. L. Hody and Robert L. Keiser.

The sensitivity, speed of response, and temperature stability of two catalytic (hopcalite) carbon monoxide detectors were measured. This work was performed as part of an evaluation of cabin atmosphere contamination in armed helicopters. The results were compared with requirements established on the basis of preliminary field studies. The devices tested did not meet these requirements primarily because of slow response, but modifications utilizing heat transfer principles may result in sufficient improvement.

Because of the compactness, as well as the shock and vibration resistance of these systems, further attempts will be made to develop design changes which will bring the specifications within the ranges desired. Results of these tests should not be interpreted as demonstrating inadequacy of the instruments when used as originally intended.

66- 3. **Combat crew debriefing. Report I (Personal interviews with nonmedical pilots).** March 1966. *(AD479883L)*

By R. A. Avner.

As the initial step in a long-range debriefing program, 50 Army aviators with recent combat experience were interviewed. A brief resume of information received in areas of environmental health, protective equipment and clothing, communications, survival equipment, medical equipment, medical evacuation, training, and morale is reported.

66- 4. **Evaluation of "Tuffy" air lock container for freefall delivery of whole blood.** April 1966. *(ADA480653L)*

By L. E. Spencer and M. S. Nix, Jr.

The purpose of this study was to evaluate the ability of the "Tuffy" air lock bag to protect blood during free fall delivery. The air lock bag appears to be adequate for free-fall delivery of liquid-filled glass and molded polyethylene containers.

66- 5. **Some crew space measurements in Army aircraft.** May 1966. *(ADA482084)*

By William P. Schane and K. E. Slinde.

Measurements were made in the cockpits of every type of aircraft presently in the U.S. Army inventory, and in most prototype aircraft scheduled for delivery to the U.S. Army through FY 1970.

From these measurements it appears that a pilot of standing height greater than 76 inches or sitting height greater than 38 inches would be unable to comfortably and safely pilot many U.S. Army aircraft. This applies particularly to the aircraft used in both fixed- and rotary-wing pilot training.

66- 6. **Real-ear sound attenuation characteristics of thirty-six ear protective devices.** May 1966. *(ADA482439L)*

By Robert T. Camp, Jr.

Real-ear attenuation characteristics of 36 ear protective devices have been summarized. Quartile values in decibels of Q_1 through Q_3 and decibels D_1 through D_9 for each of eight test frequencies are given in addition to the characteristics of individual devices. This recapitulation of attenuation data taken from measurements

of all types of devices such as earplugs, earmuffs and helmets reflects the limits of the progress of attenuation efficiency since the early 1950s.

66- 7. **Expected injury rates for experimental airborne operations.** June 1966. *(ADA633630)*

By R. A. Avner.

Probability of injury for Army paratroopers under conditions of full combat load and unprepared drop zone was estimated to be .006 (standard error equals .002, N equals 5,253). Tables were computed to allow tests of departure from this rate under experimental conditions involving up to 50 jumpers.

Fiscal Year 1967

67- 1. **Comment on correlation coefficient use.** July 1966. *(ADA635375)*

By R. A. Avner.

In computing the Pearson r, observations are identified on a nominal scale. The values assigned these observations are measured on a ratio of interval scale. Confusion of these two facts has led to the mistaken assumption that the Pearson r can measure degree of association between nominally measured variables.

67- 2. **Physiological training of HALO parachutists.** September 1966. *(ADA639342)*

By William P. Schane.

This report reviews the environment in which a HALO parachutist operates, indicates some areas in training which deserve special attention, and makes some specific operational recommendations which, if adopted, would reduce the possibility of injury or disease caused by man-environment interaction.

67- 3. **Loading of litter patients in Army aircraft.** October 1966. *(ADA642371)*

By J. C. Rothwell and R. A. Avner.

Two types of aircraft, the CV-2 "Caribou" and the CH-47 "Chinook," presently are available for medical evacuation of relatively large loads (14 and 24 litters respectively) from minimally-prepared landing sites. This report indicates maximum

rigging times for conversion of these aircraft to ambulance use, optimal crew sizes for minimum loading times, and some suggestions for loading methods and design of future large medical evacuation aircraft.

67- 4. **A rapid timing sequencer for toxic gas sampling.** November 1966. *(ADA644305)*

By G. L. Hody and H. W. Huffman.

As part of a study of toxic hazards, it is necessary to obtain samples of gases given off by rapid fire weapons and fast burning rocket motors. A solid state instrument was designed which can program solenoid valves for this purpose. The configuration chosen provides three individually adjustable interval timers. Each can be delayed from 25 to 5,000 milliseconds after firing of weapons, and can remain on for 30 to 4,000 milliseconds.

The very short sampling times which are available enable acquisition of gas samples at pressures considerably below ambient, if this is desired to protect analytical instruments or to minimize chemical interactions in the sample. By adjustment of R-C time constants, the timer range can be extended or reduced further to provide a versatile tool for future time applications. Circuit details and performance data are presented.

67- 5. **Approach to the evaluation of toxic hazards from weapons exhaust in armed helicopters.** November 1966. *(ADA646587)*

By G. L. Hody, Jr.

The complexity of flying and the environmental stresses encountered by pilots of armed helicopters are continuing challenges. Under such difficult conditions any interference with mental or sensory capabilities of the pilots can be reflected in an increased casualty rate. Helicopter-mounted weapons release a toxic exhaust which could disturb vision and hearing and might adversely affect reaction time and the reasoning process.

A brief exploratory study confirmed the impression that the weapons exhaust can reach the crew in measurable concentrations. An objective assessment of the hazard is obviously needed before costly or inconvenient corrective measures need be considered. A careful search failed to reveal existing methods for the required evaluation which involves continuous measurement of rapidly changing contaminant concentrations in a confined and vibrating environment.

An experimental program designed to explore a technique for meeting the operational requirement is being implemented in cooperation with the Air Force Rocket

Propulsion Laboratory. While the potential for a hazardous situation is very real in all armed aircraft, the concern is with the new, experimental helicopters equipped with multiple rapid fire weapons systems, in addition to those armed helicopters now deployed in the field.

67- 6. **Sound attenuation characteristics of the Army APH-5 helmet.** February 1967. *(ADA649462)*

By Robert T. Camp, Jr., and Robert L. Keiser.

An evaluation of the real-ear sound attenuation characteristics of the Army APH-5 Crash Protective Helmet was done with procedures and equipment specified by ASA Z24.22-1957.

The results show that the APH-5 offers high attenuation at test frequencies 3,000 through 8,000 Hz. However, the APH-5 has relatively low sound attenuation between 75 and 2,000 Hz. In view of the poor sound attenuation characteristics of the APH-5, it has been recommended that the present earmuffs be replaced with high efficiency ear protective muffs. If changing earmuffs is not feasible, it is recommended that the APH-5 be replaced by a helmet with high sound attenuation characteristics.

67- 7. **Continuous EKG recording during free-fall parachuting.** June 1967. *(ADA653598)*

By William P. Schane and Kenneth E. Slinde.

This study is an attempt to determine heart rate and rhythm of experienced parachutists during free-fall and during the periods immediately before and after the jumps. It includes enough subjects so that statistical inferences can be made regarding a population of experienced parachutists.

Continuous EKG readings were made of 29 experienced parachutists while each participated in free-fall parachuting exercises. A total of 98 individual exits from aircraft in flight were recorded. Mean R-R interval was 0.403 seconds just prior to exit from the aircraft, 0.363 seconds during free-fall, 0.336 seconds immediately after parachute opening, 0.369 at landing, and 0.465 seconds 5 minutes after landing.

Although there was variation in the R-R interval among the individuals, the progressive decrease of R-R interval throughout the exit and free-fall with a nadir at parachute opening was the common finding. There is marked individual difference in the duration of tachycardia before and after jumps. Over the entire group, mean duration per subject was 19.4 minutes of tachycardia prior to exit, and 30.4 minutes of tachycardia after parachute opening.

In the individual who made at least two jumps on any 1 day, the R-R intervals measured on a single individual on the first and second jumps were remarkably similar, and within the group not statistically different. A correlation matrix was computed to show relationships between various parameters studied. The corr- lation between the R-R interval and total number of jumps was opposite in direction to that which was expected, and nearly attained values that were statistically significant.

67- 8. **Sound attenuation characteristics of the Navy SPH-3 (Modified) (LS) helmet.** May 1967. *(ADA656748)*

By Robert T. Camp, Jr., and Robert L. Keiser.

An evaluation of the real-ear sound attenuation characteristics of the Navy SPH-3 (Modified) (LS) helmet was done with procedures and equipment specified by ASA Z24.22-1957. The results show that the SPH-3 (Modified) (LS) is a relatively efficient attenuator of sound throughout the audio spectrum. In view of the poor sound attenuation characteristics of the Army APH-5, it has been recommended that this helmet be replaced by the SPH-3 (Modified) (LS).

67- 9. **An improved C-ration sleeve litter.** May 1967. *(AD652096)*

By V. V. Villa and William P. Schane.

A field expedient litter improvised from discarded C-ration sleeves and two sturdy poles has been laboratory tested and found to be worthy of field use.

67-10. **The measurement of the exhaust composition of selected helicopter armament.** June 1967. *(ADA655844)*
AFRPL-TR-67-203

By P. B. Scharf, B. B. Goshgarian, H. M. Nelson, and G. L. Hody.

Crewmembers of armed helicopters are exposed to exhaust products of rapid fire machine guns and rockets. The exhaust composition of the weapons, needed for toxic hazard prediction, is difficult to obtain. In a joint Army-Air Force exploratory study, methods of analysis were evaluated and exhaust compositions for the .50-caliber and 7.62mm machine guns and the 2.75" rocket were determined. A rapid scan infrared spectrophotometer was used for immediate examination of effluent gases in order to detect reactive species. The exhaust gases were analyzed at concentrations as high as 1,000 times those present in helicopters to minimize the chance of missing any significant toxic product. A qualitative and quantitative analysis of gas phase and aerosol components is given. It may well be that the propor-

tion of carbon monoxide in the exhaust is so high that permissible exposure times can be selected on the basis of its concentration alone while still limiting exposures to all other toxic materials to safe levels.

However, significant amounts of nitrogen dioxide, ammonia, carbonyl sulfide, hydrogen cyanide, lead, and copper were found. Their contribution to the toxicity of weapons exhaust is now being evaluated and will be reported in a subsequent paper.

Fiscal Year 1968

68- 1. **Development of a paint scheme for increasing helicopter conspicuity.** September 1967. *(ADA673118)*

By James A. Bynum, Robert W. Bailey, John K. Crosley, and M. S. Nix, Jr.

Six paint designs were applied to top surfaces of helicopter rotors to assess value as an aid of conspicuity. Stimuli were presented to 40 aviators by the method of pair comparisons in actual flight tests and rankings were obtained. Data analysis indicated as first choice a scheme incorporating gloss white, fluorescent red-orange, and black.

68- 2. **Improving helicopter conspicuity through the use of painted main rotor blades.** October 1967. *(AD661067)*

By John K. Crosley, Robert W. Bailey, and M. S. Nix, Jr.

An in-flight study was conducted to determine the effect of four paint schemes, applied to the main rotor blades of UH-1D helicopters, upon helicopter conspicuity. Twenty-three observers made a total of 138 comparisons of paired aircraft. The preferred scheme incorporated white, red-orange fluorescent, and black paints.

68- 3. **Effects of downwash upon man.** November 1967. *(AD662208)*

By William P. Schane.

The threats imposed upon man by helicopter and VTOL downwash are explored. Information is derived from (1) reference material, (2) mathematical calculation, (3) individual data collection, and (4) personal experience. Eight types of threat are explored in some detail, and conclusions are drawn concerning needs for protection.

68- 4. **Analog nystagmus analyzer.** December 1967. *(AD664129)*

By George W. Beeler, Jr.

Rapid to-and-fro movements of the eye are classified as nystagmus. This movement is usually the consequence of reflex excitation of the extra ocular muscles associated with stimulation of the semicircular canals. An analog nystagmus analyzer is described that can produce continuous information concerning the duration, amplitude and slow-phase velocity of each nystagmic beat during experiments involving the vestibular apparatus.

68- 5. **Ganglion cell response characteristics from the area centralis in the intact**
NAMI **eye of the cat.** February 1968. *(AD668502)*
1031

By Roy H. Steinberg.

Ganglion cell responses were recorded with microelectrodes from the intact eye to focused spots and annuli of light delivered by a dual-beam ophthalmoscope. Only concentrically organized circular receptive fields were analyzed. Thresholds for optimal center and surround stimuli approximately were equal, as were the latencies of on-responses from the center and surround. With whole-field stimulation center-dominance was a function of light intensity. Off-responses and center-surround interaction were observed with brief flashes (5 msec, 10 msec). With increases of flash duration, the duration of the on response did not increase by the full increment of the flash until the flashes were 50 to 80 msec. At high flash-intensities the on-response extended into the off-period and the off-response weakened and disappeared; it occurred with both on-excitation and on-inhibition and for the responses of both center and surround. These intensity effects also were studied in an intracellular recording; at high intensities the rate of repolarization of the postsynaptic potential decreased and the latency of repolarization was delayed.

68- 6. **Sound attenuation characteristics of the Navy BPH-2 helicopter helmet.** March 1968. *(AD667959)*

By Robert T. Camp, Jr.

An evaluation of the real-ear sound attenuation characteristics of the Navy BPH-2 helmet was done with procedures and equipment specified by ASA Z-24.22-1957. The results show that the BPH-2 has acoustical characteristics superior to the standard Army APH-5 at frequencies from 125 Hz through 1,000 Hz. In view of the high attenuation in the speech communications spectrum, it is recommended that this helmet be considered for the use by the U.S. Army.

68- 7. **Tinted windscreens in U.S. Army aircraft.** March 1968. *(AD667960)*

By John K. Crosley.

A spectrophotometric analysis was performed on the tinted windscreen of the U.S. Army AH-1G helicopter. The results of this test, considered in conjunction with the conclusions of other researchers working with both aircraft and automobile tinted windshields, have led to the recommendation that no tinted media should be positioned between the pilot and his normal field of view during heavy overcast days, at twilight, or at night.

68- 8. **Environmental factors affecting the performance of infrared CO_2 analyzer**
NAMI **and the estimation of alveolar CO_2 tension.** March 1968. *(AD669458)*
1034

By Pei Chin Tang.

Theoretical equations were derived from known physicochemical laws to determine the effects of room temperature and barometric pressure on the performance of the infrared type of CO_2 analyzer. They were tested first experimentally and then against empirical equations derived from the Godart nomogram. These equations were found to be valid and useful in the estimation of the fractional concentration of CO_2 of gas mixtures under various environmental conditions.

Minimal gas temperature recorded with a thermistor probe at the inlet of the analyzer was used to estimate the water vapor pressure of gas samples in the analyzer chamber. This method was experimentally found to be valid in estimating CO_2 fractional concentrations of heated wet gas mixtures. It was used to estimate the alveolar CO_2 tension of human subjects with various endtidal sampling methods. Methods used by others with this type of analyzer are discussed.

68- 9. **A triaxial accelerometer module for vestibular application.** May 1968.
NAMI *(AD670231)*
1040

By W. Carroll Hixson.

A brief description is given of a 6-channel instrumentation module developed for collection of preliminary acceleration data for the a priori determination of optimal characteristics for transducers to be installed permanently on various aircraft and man-rated research devices for the measurement of vestibular-significant acceleration stimuli. The module utilizes three linear and three angular accelerometers all of the standard, commercially-available, servotype, to measure the triaxial linear and triaxial angular accelerations, along and about, respectively, the roll, pitch, and yaw axes of the test device or vehicle. Signal conditioning amplifiers equipped with feedback circuitry to facilitate in-flight adjustment of gain and high-frequency rolloff

characteristics are provided for optimal utilization of the dynamic range capabilities of magnetic tape data storage recorders. Though the instrument is used primarily to collect acceleration data in the O-5 cps spectrum, the linear channels also can be used in determining vibration levels in the 0-100 cps range.

68-10. NAMI 1043 **Instrumentation for measurement of vestibular-significant forces in helicopter.** May 1968. *(AD670230)*

By W. Carroll Hixson and Jorma I. Niven.

The report describes an airborne instrumentation system developed at minimal cost from standard commercially-available components for the in-flight acquisition and storage of helicopter low-frequency motion data pertinent to the investigation of vestibular-related pilot disorientation. System components provided to measure and record the instantaneous triaxial linear acceleration and instantaneous triaxial angular velocity of the aircraft at a given crewstation include three potentiometer readout linear accelerometers, three similar gimballess rate gyros, six signal-conditioning amplifiers, and a 7-channel battery-powered, IRIG-compatible, magnetic tape recorder.

68-11. **Painted helicopter main rotor blades and flicker-induced vertigo.** June 1968. *(AD672514)*

By James A. Bynum and John A. Stern.

Painting the main rotor blades of UH-1 helicopters led to the question of the possibility of flicker-induced vertigo in formation flights involving these helicopters. In the first of two experiments designed to answer the question, subjective responses of 38 instructors and students were obtained and evaluated after their participation in formation flights in helicopters with painted blades. In the second experiment, 10 student pilots were screened from a group of 37 on the basis of their psychophysiological and subjective responses to photic stimulations in the laboratory. These 10 then flew in formations while EEG, EOG, and eye blink data were recorded during the flight and they were debriefed immediately following the flight. Results of both experiments did not indicate the painted blades to be a source of flicker vertigo.

Fiscal Year 1969

69- 1. **User evaluation of two aircrew protection helmets.** August 1968. *(AD674184)*

By James A. Bynum.

Two aircrew protective helmets were evaluated by 24 instructor pilots who were divided equally into groups subjected to three ambient noise environments. Pilots rated the Army APH-5 and SPH-3X (Experimental) on eight categories designed to assess relative comfort, acceptability, and noise attenuation. Ratings were compared, using a split-plot factorial analysis of variance. Significant differences were found between helmets on seven of the eight characteristics rated and results favored the SPH-3X in six characteristics.

69- 2. **Selected anthropometric measurements of 1,640 U. S. Army warrant officer candidate trainees.** February 1969. *(AD688856)*

By William P. Schane, Delvin E. Littell, and Charles G. Moultrie.

The results of nine anthropometric measurements conducted upon 1,640 U.S. Army warrant officer candidates are presented. The nine measurements were selected as those which contribute most to aircrew workspace design in aircraft. Comparison of these data was performed against similar measurements conducted upon flying personnel in five separate studies by other military services.

69- 3. **An evaluation of ophthalmic plastic (CR-39) lenses in the U.S. Army aviation environment.** February, 1969. *(AD684371)*

By John K. Crosley, Robert W. Bailey, and Frank H. Fischer.

Thirty rated U.S. Army aviators with various types of refractive errors were selected to wear-test both clear and tinted plastic (CR-39) ophthalmic lenses for a period of 6 months. Subjective evaluations were made in the areas of impact resistance, scratch resistance, weight, optical clarity, comfort, cleaning ease, resistance to breakage, and accumulation of foreign material. User acceptance was quite good. Lens scratching was not found to be a significant problem. Favorable recommendations are made concerning the general use of plastic ophthalmic lenses for U.S. Army aviation personnel.

69- 4. **The somatic chromosomes of the Mongolian gerbil (Meriones unguiculatus).**
NAMI January 1969. *(AD683315)*
1056

By Steven P. Pakes.

This study was initiated to characterize the somatic chromosomes of the Mongolian gerbil (Meriones unguiculatus) prior to conducting experiments concerned with the effects of various environmental factors encountered in space flight on mammalian chromosomes.

From the study of bone marrow cells after intraperitoneal injection of colchicine, it was determined that the diploid number of chromosomes for the Mongolian gerbil is 44.

The karyotype was constructed by arranging the chromosomes into four distinct groups and includes 32 meta- or submetacentric and 10 acrocentric autosomal chromosomes. The X element was identified as a large submetacentric chromosome and the Y element as a medium-sized submetacentric chromosome.

69- 5. **Continuous EKG recording of helicopter instructor pilots: A interim evaluation.** April 1969. *(AD688857)*

By William P. Schane.

Fifty-three instructor pilots were studied with one lead of EKG for a full work day. Mean heart rates were tabulated from the record during: Administrative work (87.2 beats per minute), automobile driving (85.5 beats per minute), eating (90.1 beats per minute), and flying (92.0 beats per minute).

Using Tukey's multiple comparison of means, significant differences were found between heart rates during flying and heart rates noted while driving, and while performing administrative duties. Means of "lowest heart rate recorded" and "highest heart rate recorded" for each subject were recorded (means of 71.8 and 140.4 respectively). The activities in which the subjects were engaged at the time are reported.

There were no regular schedules of physical training or sports participation by 71.7 percent of the subjects. An 11 by 11 correlation matrix indicates subjects who have high heart rates during one activity will have comparably high heart rates during all activities, and vice versa.

Four of the 53 subjects showed arrhythmias at some time during the recording; one had 38 unifocal ventricular premature contractions during the recording period; three had atrial premature contractions.

69- 6. **Dynamic response of the head and neck of the living human to -Gx impact**
NAMI **acceleration. 1. Experimental design and preliminary experimental data.**
1064 March 1969. *(AD692069)*

By Channing L. Ewing, Daniel J. Thomas, George W. Beeler, Jr., Lawrence M. Patrick, and David B. Gillis.

Under the direction of the principle author, a joint Army-Navy research study, in cooperation with Wayne State University, is underway to determine the dynamic response of the head and neck of living human subjects to -Gx impact acceleration, using transducers to measure differential displacements and differential angular and linear accelerations of the head with reference to the base of the neck in response to the input acceleration measured at that point. A redundant photographic data system is being used for validation. Preliminary results are presented.

69- 7. **Assessment of semicircular canal function. 1. Measurements of subjective**
NAMI **efforts produced by triangular waveforms of angular velocity.** June 1969.
1073 *(AD695368)*

By Fred E. Guedry, Jr., Gale G. Owens, and Joel W. Norman.

Two methods were compared for measuring subjective angular displacement produced by triangular waveforms of angular velocity while subjects (N equals 11) were enclosed in a vertical-axis rotation device that excluded visual and auditory cues of angular motion. Accuracy of subjective estimates was influenced by the methods and by the magnitudes of acceleration comprising the stimulus waveforms. Results suggest that one of the methods, with slight modification, will provide reliable indication of the subjective effects of controlled semicircular canal stimulation. A follow-up experiment, reported separately as Part II, deals with this modification.

69- 8. **Autonomic responses to vestibular stimulation.** April 1969. *(AD689118)*
NAMI
1066 By Pei Chin Tang and Bo E. Gernandt.

Decerebrate, paralyzed cats were used to determine some autonomic effects of vestibular stimulation and to establish through which peripheral links this vestibulofugal activity was transmitted. Vestibular stimulation increased both rate and depth of respiration, as demonstrated by phrenic and recurrent laryngeal nerve recording, and a marked elevation in blood pressure accompanied this effect. When the strength of stimulation was reduced and the evoked respiratory effect weak or questionable, the systemic blood pressure declined. Vestibular stimulation elicited strong responses from the neck vagus nerve, but this vestibulofugal activity was found to be conducted exclusively in the recurrent laryngeal nerve and not in the vagus nerve proper. Only the sympathetic portion of the autonomic system responded to

nerve proper. Only the sympathetic portion of the autonomic system responded to vestibular stimulation, thus providing vestibular impulses a channel for reaching different effector organs. The responses obtained from the neck sympathetic nerve were analyzed and their characteristics described.

69- 9. **Evaluation of the human body as an airfoil.** May 1969. *(ADA032804)*

By William P. Schane and Dean C. Borgman.

Five subjects were used to determine the lift and drag characteristics of the human body held in a tracking attitude. The effects of eight different parachute pack configurations were tested to evaluate the influence of the pack upon lift and drag.

1. The mean C_L of our unencumbered subjects (0.374) corresponded to the C_L attributed to Straumann's ski jumpers (0.43).

2. Changes in parachute pack configuration significantly changed L/D, C_L and C_D. Subjects appeared to be homogenous.

3. Design of pack tray is described which, by test, had a significantly higher L/D than any currently available parachute pack tray configuration.

4. Man is not an ideal subject to test as an airfoil in the wind tunnel.

69-10. **Rod and cone contributions to S-potentials from cat retina.** June 1969.
NAMI *(AD693039)*
1071 By Roy H. Steinberg.

The problem of whether the rods contribute to S-potentials was studied in the intact eye of the cat. S-potentials from luminosity units (L-units) were evoked by small spots of relatively monochromatic light in dark and light-adapted retinae. The spectral sensitivity curve for dark-adapted S-potentials had its maximum at 500 nm, and the form of dark-adapted responses also suggested that rods were excited. The spectral sensitivity curve for light-adapted S-potentials had its maximum at 560 nm, and response latencies even at threshold were much faster than in dark adaptation. Individual S-potentials exhibited Purkinje shifts. It is concluded that rhodopsin rods contribute to S-potentials (L-type) in the cat and that cones contribute to the same responses.

69-10a. **The effect of performance relevance and feedback upon resistance to anti-**
NAMRL **cipatory stress.** August 1970. *(AD747628)*
1114

By Xenia Coulter.

This study sought to demonstrate that, in a threatening situation, if occurrence of harm depends upon performance (relevance) and information is supplied regarding performance quality (feedback), resistance to stress will be enhanced even though stress magnitude (probability of harm) remains unchanged.

Eighty aviation officer candidates were experimental subjects; 10 others were controls. A subject-paced, four-choice discrimination task was used, and all subjects were allowed an initial 5-minute practice session. Subjects anticipated either a noxious event (electric shock) or a benign event (bell).

Within each condition, four groups performed the task, each with a different combination of feedback and relevance: With neither, with both, or with one or the other. Controls simply performed the task a second time.

Results indicate that: 1) Anticipation in itself may be stressful; 2) measured by chances in performance across time, stress resistance is enhanced by both feedback and relevance; 3) stress magnitude is best measured by performance variability; and 4) performance level, which is related by a U-shaped function to stress, may reflect motivational aspects of stress.

69-11. **Rod-cone interaction in cat S-potential from cat retina.** June 1969.
NAMI *(AD693040)*
1072

By Roy H. Steinberg

Rod-cone interaction in cat S-potentials was studied by analyzing the effect of wavelength and intensity upon the form of dark-adapted responses. Flashes of white light and relatively monochromatic flashes produced responses that seemed to originate from the excitation of both receptor types. The rod response changed as a function of intensity, peaking at 2.5 log above threshold and increasing in duration at 3.0 log above threshold. The cone response seemed in some way to add to the changing rod response. V-log I curves showed that the rod response reached a ceiling (initial peak voltage) at 3.5 log above threshold while the maintained voltage leveled off at a lower intensity. Both ceilings were obscured by the apparent addition of the cone contribution. Cone and rod responses to brief orange and blue lights of moderate intensity, separated in time, added together across a complete range of intervals.

69-12. **Automated column chromatographic analysis of deacylated phospholipids.** June 1969. *(AD695635)*

By James G. Wetmur and Charles R. Wilson.

A procedure is fully described for isolation and deacylation of phospholipids from serum or tissue. Control experiments are described that ensure maximum yield with minimum degradation. A completely automated system is described for column chromatographic resolution and quantitative analysis of the fractions of a complex mixture of deacylated phospholipids. Control experiments are described that ensure maximum efficiency of chromatographic separation of and maximum sensitivity of analysis of the fractions. Elution profiles for human serum and red cells and for rat liver deacylated phospholipids are shown. All of the seven fractions are identified.

69-13. **Assessment of semicircular canal function. II. Individual differences in sub-**
NAMI **jective angular displacement produced by triangular waveforms of angular**
1074 **displacement.** June 1969. *(AD692433)*

By Gale G. Owens and Fred E. Guedry, Jr.

Mean estimates (N = 26) of short arcs of passive whole-body rotation about an earth-vertical axis were accurate when subjects used a psychophysical procedure that involved counter-displacement of a pointer on a dial. The required retrospective displacement judgments yielded more accurate mean estimates of angular displacement than were obtained in an earlier experiment which probably involved concurrent velocity matching.

The differences in response curves in the various conditions of the two experiments clearly illustrate the importance of attention to psychophysical procedures prior to attempting to develop models of the vestibular end-organs to explain results. The method used in this experiment is sufficient to detect prominent individual differences within a sample of aviation training candidates, and the results obtained thus far indicate high test-retest reliability (r = .94).

69-14. **The rod aftereffect in S-potentials from cat retina.** June 1969. *(AD693041)*
NAMI
1075 By Roy H. Steinberg.

The relation of the rod aftereffect to percentage rhodopsin bleached was studied in S-potentials from cat retina. At threshold, flashes which produced the rod aftereffect bleached only very small quantities of rhodopsin; and at a fixed flash duration, the duration of the aftereffect increased as a function of log intensity. The aftereffect's threshold occurred at about the intensity which saturated the maintained voltage. With flash intensity fixed (6.5 log td. scotopic) and flash duration increased

(0.5 to 64.0 seconds) the duration of the after-effect was a linear function of exposure time. The duration continued to increase after an exposure of 16 sec, even though at least 99 percent of the rhodopsin had been bleached. It is concluded that the aftereffect originates from something which accumulates after the maintained voltage in rod pathways reaches a ceiling. The accumulation can continue at a fixed rate irrespective of the bleaching rate.

69-15. **Forms of closed circular DNA in rat liver during regeneration and following aminoazo-dye carcinogenesis.** June 1969. *(AD689451)*

By James G. Wetmur and Charles R. Wilson.

The closed circular forms of DNA of rat liver have been observed during aminoazo-dye carcinogenesis, during regeneration following partial hepatectomy and in control animals. Paucidisperse multiple mitochondrial forms were not observed. Polydisperse smaller molecules were observed following treatment with chemical carcinogens. The cumulative frequency histogram shows the same profile as others observed in HeLa cells. The relative quantity of the small circles to the mitochondrial circles normally present was extremely small.

No conclusions could be drawn regarding the source of these molecules. We conclude that neither regeneration nor carcinogenesis results in an alteration of the genetic recombination apparatus of a magnitude which might yield significant quantities of the two aberrant forms of closed circular DNA.

69-16. **Temperature dependence of venom phospholipase A and relate haemolysis.** June 1969. *(AD690800)*

By William P. Schane, James G. Wetmur, and Charles R. Wilson.

Phospholipase A activity of the venom of Crotalus admanateus was found to increase by a factor of two for every 10 degrees C increase in temperature. A percentage of haemolysis of red cells by lysolecithin produced by phospholipase A occurred at two times lower lysolecithin concentration for every 10 degree C decrease in temperature. Under all conditions, percent lysis increased with decreasing temperature, although initially the temperature dependence is small. At any time, decreasing the temperature in a complex reaction mixture would be expected to produce an instantaneous increase in the percentage of cells lysed.

69-17. **Effects of cyanide and 2 deoxyglucose on proximal tubular function in the rat kidney.** June 1969. *(AD691020)*

By Stephen W. Weinstein.

A series of 13 experiments was performed to study the effects of cyanide, an oxidative inhibitor, and 2 deoxyglucose (2DG), a glycolytic inhibitor, on the function of the proximal tubule of the rat's kidney. The technique utilized was split oil droplet microperfusion of surface proximal nephron segments with sequential photomicrography. Isotonic saline was the control perfusion fluid. Cyanide reduced the reabsorptive rate of the perfused nephron segments to 50 percent of the control. 2DG had no effect on saline reabsorption. Cyanide plus 2DG perfused simultaneously in saline inhibited reabsorption to the same degree as did cyanide alone. These results are interpreted as indicating almost total dependence of proximal tubular reabsorption of filtrate upon energy available from oxidate metabolism. Since reabsorption of filtrate in this segment is mediated through active sodium transport, it would appear that oxidative metabolism and not glycolysis is the energy source for this process.

69-18. **Effects of 2, 4 dinitrophenol on proximal tubular sodium reabsorption and permeability on nonelectrolytes in the rat kidney.** June 1969. *(AD691104)*

By Stephen W. Weinstein.

A series of 19 experiments was performed to study the effects of 2,4 dinitrophenol (2,4 DNP), an uncoupler of oxidative phosphorylation on the capacity of the proximal tubule of the rat kidney to reabsorb isotonic sodium chloride and to limit passive permeation on nonelectrolytes. The technique utilized was sequential photomicrography of split oil droplet microperfusions of surface proximal convolutions. The perfusion fluids were isotonic solutions of saline, mannitol, sucrose, and raffinose.

The addition of 2,4 DNP had no effect on isotonic saline reabsorptive rate. However, it increased the rate of reabsorption of the nonelectrolytes.

These results suggest an intimate linkage in the proximal convolution of sodium transport directly to the electron transport system since 2,4 DNP prevents oxidative phosphorylation without inhibiting electron transport. In contrast, permeability of this tubular segment to nonelectrolytes is enhanced by 2,4 DNP. At least two mechanistic and two function explanations are possible for this effect. These are discussed and their implications considered.

69-19. **The effect of prior exposure to a harmful event upon subsequent performance under threat.** June 1969. *(AD705532)*
NAMI
1077

By Xenia B. Coulter and Mary Anne Overman.

Earlier research stressed the need for controlling magnitude of threat when measuring susceptibility to fear of harm (electric shock). Level of threat was manipulated before testing by varying the intensity of demonstrated shock and the stated probability of receiving shock at a specified point during a given experimental performance task.

The present study investigated effects of: 1) The stated probability at 0.25 versus 0.85 with no pretest shock demonstration and 2) pretest shock demonstration versus no demonstration with the stated probability held constant at 0.65. Subjects were 70 entering aviation trainees. The task was a subject-paced four-choice discrimination task. Ten subjects were used as controls, with the remainder divided among the experimental conditions. A 5-minute practice period without threat preceded a 5-minute experimental period for all conditions. It was concluded that: 1) Shock demonstration is not necessary, and its elimination would provide a more useful range for individual difference measurement; 2) the 0.65 probability is better for producing measurable performance decrement than either the lower or higher extremes of 0.25 and 0.85; 3) threat perception as measured by mean performance level across time may be as useful a parameter as performance decrement immediately preceding the anticipated harmful stimulus.

Fiscal Year 1970

70- 1. **Micropuncture studies on the mechanism of sulfate excretion by the rat kidney.** July 1969. *(AD692845)*

By Stephen W. Weinstein.

A series of free flow micropuncture experiments were performed on rats undergoing sodium sulfate diuresis. End proximal tubular fluids and ureteral urines from the punctured kidney were collected. The data indicates that tubular fluid/plasma (TF/P) ratios for sulfate remained close to 1.0 and filtrate reabsorption was quantitatively normal during sulfate infusion in the proximal tubule. Final urine analysis suggested that all sulfate leaving the proximal convolution is excreted. The data is interpreted as evidence that sulfate is not handled by a T_M limited mechanism in the rat kidney. Rather it appears dependent upon filtration rate, proximal tubular reabsorption rate and plasma concentration of the anion. A comparison of bicarbonate reabsorption during carbonic anhydrase inhibition to sulfate reabsorption in the rat nephron suggests greater proximal passive permeability to sulfate than bicarbonate and equally restricted distal nephron permeability.

70- 2. **Real-ear sound attenuation characteristics of CBS Laboratories' Mark II earphone enclosures.** July 1969. *(AD693261)*

By Robert T. Camp, Jr., and Ronald F. Kovacs.

The real-ear attenuation characteristics of the CBS Laboratories' MARK II earphone enclosures were determined by standard procedures and equipment specified by ASI Z24.22-1957. The enclosures mounted in an Army APH-5 helmet. The results of the tests show that the MARK II earphone enclosures do improve the attenuation characteristics of the APH-5 at frequencies from 75 to 500 Hz. At higher frequencies between 3K and 8K Hz the attenuation was less than that offered by the standard APH-5 earmuff. A comparison of the overall sound attenuation characteristics of the MARK II enclosures and the SPH-3 (Modified) shows that the latter has superior attenuation characteristics.

70- 3. **Visibility from the rear seat of the U.S. Army O-1A (Bird Dog) aircraft.** August 1969. *(AD693797)*

By John K. Crosley and Robert W. Bailey.

The dynamic visual field of view was measured from the rear seat of the U.S. Army O-1A (Bird Dog) aircraft. Subjects from the 5th and 95th percentile level sitting eye heights were used to determine the changes in field of view when the short man occupied the front seat and the tall man the rear, and vice versa. Changes occurring as a result of using a cushion, sitting in a fixed position, or moving the extent of the seat harness also were measured. Recommendations are made concerning seat adjustment characteristics, rear window design, the availability of instruments to the instructor pilot in the rear seat, and the weather standards for dual VFR flight.

70- 4. **Interaction between stress, vigilance and task complexity in flight personnel.** (This report was not published.)

70- 5. **Measurement of the toxic hazard due to firing the weapons of the UH-1B armed helicopters.** August 1969. *(AD697765)*

By G. L. Hody, Jr.

The toxic exhaust products of machine guns and rockets fired from armed helicopters can create a hazard for the crew. A toxic hazard evaluation was carried out with the UH-1B armed helicopter. Special methods were used to measure rapidly changing levels of carbon monoxide in the helicopter during actual flight testing.

The exposure to metallic particles also was recorded. No toxic levels of weapons exhaust were present in the cabin during any practical mission profile with the specific weapons tested. These tests are part of a continuing armed helicopter toxic hazard study program at USAARL.

70- 6. NAMI 1093 **The effect of semicircular canal stimulations during tilting on the subsequent perception of the visual vertical.** November 1969. *(AD700908)*

By Charles W. Stockwell and Fred E. Guedry, Jr.

When a man is accelerated on a centrifuge, the direction of gravitoinertial vertical changes relative to his body. However, a lag occurs in his perception of this change. The hypothesis has been advanced that the perceptual lag in this situation is partly the result of a conflict between signals arising from the semicircular canals and from the otolith organs. To test this hypothesis, subjects were tilted in such a way that they received consistent semicircular canal and otolith signals. This was accomplished simply by tilting them 30 degrees from upright in their frontal plane. Immediately after being tilted, these subjects made estimates of the vertical which were approximately accurate, and they continued to make accurate estimates throughout a 140-second judgment period. The absence of a perceptual lag under these circumstances supports the hypothesis.

70- 7. NAMI 1094 **Sample helicopter flight motion data for vestibular reference.** November 1969. *(AD701696)*

By W. Carroll Hixson and Jorma I. Niven.

This report presents low-frequency linear and angular motion flight data collected on a noninterference basis aboard the following military helicopters: AH-1G, UH-1B, UH-1D, OH-6A, CH-54, CH-47, and UH-2B. Measurement data recorded during various tactical maneuvers and routine flight operations included the triaxial linear accelerations occurring along the roll, pitch, and yaw axes and the triaxial angular velocities occurring about the same three reference axes.

70- 8. NAMI 1092 **The semiautomated test system: A tool for standardized performance testing.** November 1969. *(AD702903)*

By H. Rudy Ramsey.

For performance tests to be truly standardized, they must be administered in a way that will minimize variation due to operator intervention and errors. Through such technological developments as low-cost digital computers and digital logic modules, automatic test administration without restriction of test content has be-

come possible. A Semiautomated Test System (SATS), incorporating programmable digital logic modules for control, has been developed to allow an experimental psychologist, unassisted and with a minimum of special training, to set up and modify tests or experiments; thus, it is especially useful for exploratory studies. The structure of the SATS is described and an example is presented to clarify the operations involved in its use.

70- 9. **The design of a literature file in aircraft-related environmental medicine.** November 1969. *(AD701014)*

By G. L. Hody

The U.S. Army Aeromedical Research Laboratory often is required to make specialized measurements and perform applied research in aircraft-related areas of environmental medicine. Rapid access to the periodical literature is essential for the completion of many of these projects.

A growing file of reprints from the periodical literature is available at USAARL. A method for the orderly storage of the reprints in printed form and a separate scheme for rapid retrieval of abstracts was developed for the file. Both methods were based upon the natural organization of the data. Storage of papers within the file will be based on the major topic of each reprint while retrieval will be accomplished by the use of key words. The combined system is expandable and can be easily adapted to a variety of mechanical, electro-optical and computer storage retrieval systems.

70-10. **Influence of vestibular stimulation and display luminance on the performance of a compensatory tracking task.** February 1970. *(AD704859)*
NAMI 1097

By Richard D. Gilson, Alan J. Benson, and Fred E. Guedry, Jr.

Loss of acuity for visual details in aircraft during unusual maneuvers has been documented by Melvill Jones. Recent investigations of this problem have served to define the magnitude of semicircular canal stimulation necessary to provide nystagmus of sufficient strength to degrade visual acuity. Present work extends former observations by investigating the effects of levels of illumination during semicircular canal stimulation on the performance of a task requiring vision. The illumination levels were selected to encompass the range used in aircraft cockpits.

A compensatory tracking task with an aircraft instrument as the display provided an indirect measure of this loss of visual acuity and a direct practical measure of performance. It was found that decreasing the luminance of the display over a range from the highest to the lowest levels normally used in cockpits significantly magnified the degradation of tracking performance resulting from vestibular stimulation, while

producing only small changes in nystagmus. Without vestibular stimulation, the same changes in luminance resulted in no significant alterations in tracking performance. It appears that for a given level of nystagmus, performance of visual tasks may or may not be impaired depending on the level of illumination. It is suggested that the adverse effects of retinal smear resulting from nystagmus-produced image movement across the retina are augmented by decreases in luminance. Application of these results to aircraft operation is discussed.

70-11. **Two procedures for applied and experimental studies of stress.** February
NAMI 1970. *(AD716967)*
1099

By Robert S. Kennedy.

To compensate for the low reliability of physiological manifestations of sympathetic nervous system activity two methods are offered. The first method requires a major research program by which a valid criterion of stress would be determined by experimentation, and then predictors of this criterion would be obtained empirically by correlational techniques. These predictors then could be cross validated. By using the predictors, the influences of psychological stress and physiological stress could be separated. Whether a functional relationship exists between the magnitude of the response to stress and the probability of its occurrence then could be determined. The second method is similar, but less exact. It has been used successfully in motion sickness studies and avoids the necessity of a long exploratory program with numerous pilot studies.

A procedure for the control and the regulation of the perception of the magnitude of the stress to the organism (human and infrahuman) is offered for use with the two methods. The lack of suitable control of this factor is discussed in connection with previous research.

70-12. **A comparison of subjective responses to semicircular canal stimulation**
NAMI **produced by rotation about two axes.** May 1970. *(AD709591)*
1106

By Fred E. Guedry, Jr., Charles W. Stockwell, and Richard D. Gilson.

A practical procedure has been developed for obtaining reliable measures of sensation associated with semicircular canal stimulation. Theoretically these measures can be used along with measures of nystagmus to estimate several vestibular response system parameters relevant in the clinical assessment of pilot vertigo. In this experiment, responses produced by stimulation of the horizontal semicircular canals are compared with those produced by stimulation of the vertical canals.

Group mean estimates of subjective angular displacement obtained from 40 naval flight students were approximately accurate for stimulation of both horizontal

and vertical canals. Significant individual differences were found within the group. From the responses obtained, mean estimates of vestibular system parameters were calculated. The method appears to be a reliable and practical means of measuring the $K_s A/^{\blacktriangle}$ parameter which has not been assessed in the past due to lack of a suitable method. The theoretical basis of the method is discussed.

70-13. **The composition of the exhaust products of military weapons: A comparison of calculated and experimental results.** March 1970. *(AD871485L)*
USAFAR-1948

By Ludwig Stiefel and George L. Hody.

The composition of the combustion products of the weapons used in armed aircraft and other military vehicles must be known accurately before their potential for creating a toxic hazard for crewmembers can be evaluated. Experimental determination is technically difficult and expensive, while computer-assisted calculation, the alternate method, is of unknown applicability. Due to the joint efforts of USAARL, the Air Force Rocket Propulsion Laboratory, and the Frankford Arsenal Pitman-Dunn Laboratories, some experimental and calculated data for the same weapons systems became available. In this report, the results of the two studies are presented and contrasted, and the usefulness of computation methods in exhaust composition prediction is discussed.

70-14. **Orientation-error accidents in regular Army aircraft during Fiscal Year 1967: Relative incidence and cost.** June 1970. *(AD710987)*
NAMRL 1107

By W. Carroll Hixson, Jorma I. Niven, and Emil Spezia.

This report is the first in a longitudinal series of reports dealing with the magnitude of the pilot disorientation/vertigo accident problem in regular Army fixed-wing and rotary-wing flight operations. Factors involved in the development of an operational definition of the orientation-error class of aircraft accidents are discussed. Incidence and cost data presented for Fiscal Year 1967 include a total of 57 major and minor orientation-error accidents (19 of which were fatal), resulting in 45 fatalities, 105 nonfatal injuries, and a total aircraft damage cost of $10,144,034. The contribution of rotary-wing orientation-error accidents to this total was 55 accidents (18 of which were fatal), resulting in 44 fatalities, 104 nonfatal injuries, and a total aircraft damage cost of $10,116,847.

Fiscal Year 1971

71- 1. **Orientation-error accidents in regular Army UH-1 aircraft during Fiscal**
NAMRL **Year 1967: Relative incidence and cost.** August 1970. *(AD715107)*
1108

By W. Carroll Hixson, Jorma I. Niven, and Emil Spezia.

This report is the first in a longitudinal series of reports dealing with the magnitude of the pilot disorientation/vertigo accident problem in regular Army UH-1 helicopter operations. Incidence and cost data presented for Fiscal Year 1967 include a total of 50 major and minor orientation-error accidents (15 of which were fatal), resulting in 38 fatalities, 88 nonfatal injuries, and a total UH-1 aircraft damage cost of $7,542,177.

71- 2. **Major orientation-error accidents in regular Army UH-1 aircraft during**
NAMRL **Fiscal Year 1967: Accident factors.** October 1970. *(AD730478)*
1109

By W. Carroll Hixson, Jorma I. Niven, and Emil Spezia.

This report is one of a longitudinal series of reports dealing with the pilot disorientation/vertigo accident problem in regular Army UH-1 helicopter operations. Individual case history data extracted from the USABAAR master aircraft accident files are presented on 44 UH-1 *major orientation*-error accidents that occurred during Fiscal Year 1967. Summary data listings involving a variety of operational and pilot-related accident factors are presented for each of the 44 cases. The listings are arranged to distinguish between those factors and events present before takeoff, i.e., the initial conditions associated with a given accident, and those that occurred or were manifested during the actual airborne phase of the accident flight.

71- 3. **A program for analyzing data with more than one score per subject.**
(This report was not published.)

71- 4. **Lighting factors affecting the visibility of a moving display.** August 1970.
NAMRL *(AD715625)*
1113

By Richard D. Gilson and Robert H. Elliott.

Compensatory tracking performance was shown to be substantially degraded by oscillation of the visual display at both 1.0 Hz and 2.0 Hz. The severity of this decrement was significantly altered by changes in both the color and the intensity of the display illumination. Performance was significantly better with red light illuminating the display at 0.05 mL than with blue light at the equivalent luminance. This im-

provement in performance was similar in magnitude to that found for the increase in broadband illumination of the display where luminance was increased from one-half log unit below to one-half log unit above 0.05 mL. Visual mechanisms that may have been responsible for these findings are suggested and practical considerations of instrument lighting are discussed.

71- 5. **Family health education and its place in the training of student aviators: A method.** August 1970. *(ADA711927)*

By Stanley C. Knapp

Flight surgeons often are poorly understood; and their real missions are not realized by military aviation students and their families. The flight surgeon, because of his prominent position in selection and retention of the student aviator, may represent a threat to the aviator's career. The Army Aviation Training Program is rapidly expanding. Formal student-flight surgeon contact is rare. A need for improving the image of the flight surgeon was realized by the Department of Aeromedical Education and Training, Army Aviation School, Fort Rucker, Alabama. A method of health education discussions with the wives of student aviators was developed.

The aims of the discussions were twofold. In the first place, improving the image of the flight surgeon by early and informal contact and enlisting the help of the wives in the care of their husbands as part of the flight surgeon's mission, and the presentation of a number of vital aviation topics pertinent to the health and safety of the husband-aviators.

71- 6. **(This report number was not used.)**

71- 7. **Reliability and validity of the brief vestibular disorientation test compared**
NAMRL **under 10-rpm and 15-rpm conditions.** August 1970. *(AD716767)*
1115

By Rosalie K. Ambler and Fred E. Guedry, Jr.

A Brief Vestibular Disorientation Test (BVDT) was developed that involves observer assessment of subjects' reactions produced by head movements in a rotating chair. Reliability of observers has been demonstrated, and significant validation and cross-validation coefficients have been reported for criteria of pass versus various types of separation from pilot training.

It also has been established that the BVDT score significantly augmented the multiple correlation of existing aviation selection variables with the same criteria. The purpose of this study was to determine if reliability, validity, and augmentation

of correlation could be obtained with less disturbance to the subject caused by the 15-rpm speed of rotation used thus far in the BVDT. Reduced disturbance and aftereffects are desired because the BVDT now is envisioned as becoming part of the entering flight physical, and procedures that might either impair performance on the other tests or require recovery periods must be held to a minimum.

The BVDT procedure used here was identical to two previous studies except that a speed of 10-rpm was used instead of 15-rpm. Subjects were 157 flight students who were tested within the first 4 days of reporting for training. Retesting of 72 of the subjects was conducted 9 weeks later. The test-retest and rater reliability coefficients obtained were not quite so high as for those who had the 15-rpm procedure, but they were of acceptable magnitude. The validity coefficients were approximately the same as those obtained for 15-rpm, and significant augmentation of the existing selection battery and cost effectiveness was demonstrated. It was concluded, therefore, that the 10-rpm BVDT was a feasible procedure. It also was concluded that, because the mean score for the 10-rpm group was lower than the mean for either of the two 15-rpm groups used previously, subject disturbance had been reduced.

71- 8. **Analyzing affects of threatened harm.**
NAMRL
1116 (This report was not published.)

71- 9. **Medical and physiologic effects of ejection and parachuting: An overview.** August 1970. *(AD711928)*

By Stanley C. Knapp.

Design requirements for ejection seats and personal survival equipment sometimes omit as a criteria man's physiologic and psychologic limitations. Man's ability to come through the ejection and parachute descent sequences uninjured is influenced directly by the design of the equipment and his experience in the techniques of proper use. Many limiting physiologic factors must be considered. Response to multiple accelerations in multiple axes, wind blast, effects of temperature extremes, anthropometric problems, and neuromuscular response are among the factors discussed.

Engineers will find a knowledge of human factors vital to the design of seat restraint systems, cushions, accessory packs, control placement, catapults, the parachute, etc. This broad overview reviews significant literature on sport free-fall, military static line, HALO, and ejection parachuting statistics. Modes of injury and morbidity during ejection and parachuting are detailed.

71-10. **Problems of adaption to long range, large scale aerial troop deployments.** September 1970. *(AD714368)*

By Stanley C. Knapp.

This paper discusses the demonstrated stresses and adaption problems during large scale, long range, rapid reaction time, aerial troop deployments. NATO exercise REFORGER I, January 1969, and other recent large scale aerial troop deployments are discussed. Long range aerial troop transport and deployment is a technological achievement of the 1960s that has influenced and shaped international political thinking and military strategy. "Supertransport aircraft," capable of around-the--world troop lifts, are a reality in the military inventory. Careful consideration has been given to the aircrews that operate these aircraft. It is necessary to carefully assess the position, role, and regard for the individual soldier, the "passenger," whom all of this aviation technology and engineering supports.

Historically, soldiers have proven to be flexible, well motivated, and capable of great personal and group ingenuity and adaption in the face of stress. These factors create fighting forces that are able to go almost anywhere, at any time, by any means, and remain efficient and effective.

Certain human factors and parameters of personal adjustment and adaption, however, are relatively fixed or slow. Among them are requirements for sleep, food, fluids, exercise, warmth, shelter, sensory stimulation, recreation, periods of quiet, and physical and psychological support. Man has proven biological or circadian rhythm that is essentially unalterable over prolonged periods of stress, let alone abrupt exposure. Man does not immediately adapt to sudden environmental changes, i.e., sea level to mountainous, arctic to equatorial, tropical to arid, or pastoral to aquatic.

71-11. **Living human dynamic response to -G_x impact accelerations. II. Acceler-**
NAMRL **ations on the head and neck.** October 1970. *(AD717130)*
1122

By Channing L. Ewing, Daniel J. Thomas, Lawrence M. Patrick, George W. Beeler, Jr., and Margaret J. Smith.

A methodical investigation and measurement of human dynamic response to impact acceleration was conducted as a joint Army-Navy-Wayne State University investigation. Details of the experimental design were presented at the Twelfth Stapp Car Crash Conference in October 1968.

Linear accelerations were measured on the top of the head, at the mouth, and at the base of the neck. Angular velocity also was measured at the base of the neck and at the mouth. A redundant photographic system was used for validation. All data were collected in computer compatible format and data processing was by

digital computer. Selected data in a stage of interim analysis on 18 representative human runs of the 236 human runs completed to date are presented.

Review of the data indicates that peak accelerations measured at the mouth are higher than previous estimates. The time relationship of the peak resultant mouth accelerations to the peak sled accelerations for this particular accelerator and restraint system is described. The maximum peak resultant mouth acceleration was 47.8 g and the peak mouth angular velocity on another run exceeded 30 rad/sec, on nominal 10 g, 250 g/sec runs with no evidence of unconsciousness or neurological deficit attributable to the acceleration.

Representative plots of the human dynamic response are presented, discussed, and compared. A first order linear regression analysis for the peak mouth resultant acceleration and the peak mouth angular velocity obtainable from the peak sled acceleration is presented. Important similarities discovered in the time phasing of the human dynamic response to impact accelerations are presented and discussed.

71-12. NAMRL 1123 **Comparison of tracking task performance and nystagmus during sinusoidal oscillation in yaw and pitch.** October 1970. *(AD717596)*

By Alan J. Benson and Fred E. Guedry, Jr.

Sinusoidal torsional oscillation (0.04 Hz, peak angular velocity ±60 to ±159 deg/sec) degraded subjects' performance of a compensatory tracking task because inappropriate nystagmic eye movements impaired visibility of the display. Responses to angular oscillation in yaw and pitch were compared. During angular motion in the pitch-forward direction the nystagmus frequency and slow phase velocity, and the consequent performance decrement, were significantly greater than during the pitch-back half cycle. No such asymmetry was found during oscillation in yaw where the nystagmus measures and error scores were similar to those obtained in the pitchback half cycle. The poorer suppression of vestibular nystagmus during pitch-forward motion is attributed to the higher frequency and smaller amplitude of downbeating nystagmus. Angular oscillation in pitch induced motion sickness more rapidly than a comparable yaw-axis stimulus.

71-13. **The use of high intensity Xenon lighting to enhance U.S. Army aircraft day/night conspicuity.** January 1971. *(AD718639)*

By John K. Crosley, William E. McLean, Ronald G. Tabak, and Robert W. Bailey.

In-flight studies were performed at Fort Wolters, Texas, to compare the effectiveness of aircraft mounted, high-intensity Xenon flashtube lights for increasing the conspicuity of small trainer helicopters (TH-55) during both daylight and nighttime

flights. Twenty-eight subjects rated both lighted and nonlighted aircraft visibility as viewed from the ground and from air-to-air in differing flight modes. Data are presented to indicate the increase in aircraft conspicuity available through the application of this type of lighting.

71-14. **Effects of Isoniazid on performance.** February 1971. *(AD721624)*

By Richard O. Nossman and Mark A. Hofmann.

Nine aviators who converted from negative to positive on a tuberculosis tine test performed a variety of laboratory tests given before, during, and after INH therapy. INH was administered prophylactically at dosage levels of 300 mg per day. The tasks consisted of reaction time (auditory and visual), rotary pursuit tracking, mental multiplication and digit span. The data did not indicate that the drug adversely affected performance on any of the tasks utilized.

71-15. **Nystagmus response during rotation about a tilted axis.** March 1971.
NAMRL *(AD726172)*
1129

By Charles W. Stockwell, Gene T. Turnipseed, and Fred E. Guedry, Jr.

A persistent horizontal nystagmus response is elicited when a man is rotated at constant velocity about an earth-horizontal axis. This response comprises two components: A directional bias and a cyclic modulation of the bias level. Observations were made of the effects of the bias stimulus variables: Rate of initial acceleration, rate of steady rotation, and angle of tilt of the rotation axis. Bias and cyclic modulation were affected differently by stimulus variables, especially by rate of steady rotation, suggesting the presence of two separate response mechanisms.

Previous experiments indicate that both mechanisms depend upon the otolith system, although the possibility of a semicircular canal contribution remains. Thus it is reasonable to conclude that these response components provide a means of assessing the dynamics of otolith-regulated responses.

71-16. **Nystagmus and visual performance during sinusoidal stimulation of the**
NAMRL **vertical semicircular canals.** March 1971. *(AD726173)*
1131

By Fred E. Guedry, Jr., and Alan J. Benson.

Men were positioned on their sides and oscillated sinusoidally (0.04 Hz, peak velocity +90 deg/sec) about an earth-vertical axis. Initially, nystagmus slow phase velocity was about equal during the forward- and backward-pitch halves of the stimulus cycle in darkness; but when subjects tracked a dimly illuminated aircraft instru-

ment, slow phase velocity during forward-pitch was about 10 times that during backward-pitch. Consequently, tracking errors were much greater during forward-pitch. Change in luminance level from 0.01 ft-L to 1.0 ft-L produced small, statistically significant decrements in slow phase velocity and substantial improvements in tracking performance. Following this part of the experiment, nystagmus was again recorded in darkness. There was a differential decline in slow phase velocity, the slow-phase-down response showing significantly greater decline. Stimulus-response phase relations also were altered for the slow-phase-up response. It is proposed that interactions between eyelid and eyeball movements caused different frequencies of upbeating and downbeating nystagmus which, in turn, produced different visual suppression of slow phase velocity in the two halves of the stimulus cycle. The asymmetric visual suppression may have contributed to the asymmetric habituation of the two reactions.

71-17. **Crash injury economics: The costs of training, maintaining, and replacing an Army aviator.** April 1971. *(AD725482)*

By Armand E. Zilioli.

While the hardware costs of Army aviation accidents are known, the monetary costs of injuries and fatalities have not been determined. In order to ascertain these costs, the training and maintenance costs of aviators are needed. This report presents a study of training and maintenance costs of Army aviators in all grade levels from training up to, including, and after an accidental death.

A random sample of five Army aviators in each grade level was used in the study. Cost data following their hypothetical death in an Army aircraft accident were projected using Social Security Administration and Veterans Administration actuarial figures, data, and tables. The minimum cost for training a bachelor rotary-wing warrant officer candidate with no previous military experience is $38,035. The total cost to the United States Government up to and after the accidental death of an Army aviator in an Army aircraft can range from $102,670 to $759,954.

Monetary costs to replace the aircraft crew often exceed by several times the cost to replace the aircraft.

71-18. **Crash injury economics: Injury and death costs in Army UH-1 accidents in Fiscal Year 1969.** December 1971. *(AD741363)*

By Armand E. Zilioli and Jay C. Bisgard.

Injury and fatality costs of Army aircraft accidents have never been determined. During FY 69, there were a total of 546 major and minor aircraft accidents involving UH-1 type helicopters. This report presents an economic study of 160 individuals

with major injuries and 227 fatalities which occurred in 129 of these accidents. Minor injuries were not considered in this study. Personnel costs of aircraft accidents were evaluated using hospitalization and convalescence times and costs, death benefits, and Veterans Administration and Social Security Administration benefits. These costs were computed using the least expensive method. Human costs, such as pain, suffering, deformity, or the loss of earning power are factors which are real costs but which cannot be determined. The total treatment time for the 160 injured individuals was 19,097 days. When considered on the basis of a 246-day work year, the total treatment time equaled 77.6 work years. The average personnel costs of an aircraft accident ranged from $38,227 for a survivable accident to $408,757 for a nonsurvivable accident. The average hardware cost of an aircraft accident was $220,772. The monetary cost of injuries and fatalities can often considerably exceed the sum required to replace the aircraft.

71-19. **Engineering test of lightweight underwear of the winter clothing system: Thermal protection.** June 1971. *(AD732429)*

By Francis S. Knox, III, George R. McCahan, Jr., Thomas L. Wachtel, Walter P. Trevethan, Andrew Martin, David R. DuBois, and George M. Keiser.

This report describes the use of a bioassay technique to evaluate the fire resistant and thermal protection capabilities of the lightweight underwear of the Army winter flight clothing system. Samples of the fabrics under consideration for inclusion in the Army winter flight clothing system were mounted on a template and held in contact with the side of a pig. Thus protected, the pig was exposed to a flame source calibrated to simulate a well-developed JP-4 fire.

Exposure times of 1.75, 3.50, and 7.0 seconds were used. Evaluation of resultant skin burns showed that none of the fabric systems as evaluated, meet the essential requirement of 10 seconds protection. Single-layered fabric (Nomex shell fabric) offers slight protection and double-layered fabric systems (Nomex outer shell either with Nomex underwear or 50 percent cotton/50 percent wool underwear) offer more than three times the protection of single layers, but still fail to provide 10 seconds of protection. The 50 percent cotton/50 percent wool underwear offers equal or better protection than experimental Nomex underwear worn under standard Nomex outer shell. Washing does not affect thermal protection. The data further indicate that the method using pigs provides a very consistent and meaningful way of evaluating thermal protective fabrics.

71-20. **Effects of alcohol ingestion on tracking performance during angular accel-**
NAMRL **eration.** May 1971. *(AD729679)*
1133

By William E. Collins, Richard D. Gilson, David J. Schroeder, and Fred E. Guedry, Jr.

Following practice, two groups of 10 subjects each were given prebaseline tests of tracking performance in both static (stationary) and dynamic (whole body angular acceleration) conditions. One group then received orange juice which contained 2.0 ml of 100-proof vodka per kg of subject weight; the other group drank orange juice with a few drops of rum extract added. All subjects were led to believe that they were receiving alcohol. Additional tests were conducted 1, 2, 4, 8, and 10 hours after drinking.

All tests were in total darkness with the exception of the visual display which was illuminated to a level recommended for cockpit instruments. Static tracking error declined slightly for the control group, but increased over the predrinking levels during the 1-, 2-, and 4-hour tests for the alcohol group; only the 1-hour scores differed significantly from the prescores for the alcohol group.

In comparing the two groups, static tracking errors for alcohol subjects were significantly higher than those of control subjects only at the 4-hour session when the effects of alcohol were beginning to wane. However, in the dynamic tests, alcohol subjects made significantly more tracking errors than control subjects during 1-, 2-, and 4-hour sessions. These data suggest that eye-hand coordination may show little or no impairment following alcohol ingestion in static situations, yet may be seriously degraded during motion.

71-21. **Environmental effect on attack helicopter crew task performance in the NATO theater.** May 1971. *(AD726949)*

Edited and compiled by Stanley C. Knapp.

This report addresses the unique tasks, requirements, and demands upon attack helicopter crews and the effects of the environment upon the performance of these tasks. Night operations under low ceilings, reduced visibility, high or low speeds, nap-of-the-earth flight profiles, and a threat of sophisticated antiaircraft weaponry is defined as the "worse-credible-environment" for the NATO Theater. In this environment, the attack helicopter and its crew will be expected to fly a large percentage of its missions and deliver its ordnance with a high degree of accuracy.

Task performance is outlined in a detailed matrix. Collective tasks are grouped into functional task clusters. The effects of climatic conditions, the hostile threat, and social and civil factors upon performance of these task clusters are discussed. The effects of the machine/mission-created environment are presented and include

hypoxia, toxic products, temperature extremes, visual and optical problems, acoustics, vibration, and human factors. Aircraft safety and reliability are directly affected by all of these factors.

Simple and practical solutions for nearly all factors presented are available with current technology. Application and implementation of these solutions, with explicit consideration given to environmental factors and human capability, will ensure maximum performance from both men and machines.

71-22. **The neurological effects of INH.** December 1971. *(AD744808)*

By J. E. Jordan, Stephen Shields, and Dan Bochneak.

INH was given for one year to a group of 28 volunteer civilian aviators. Neurological examinations, mental status examinations, EEGs, and visual evoked potentials were monitored at control, 6 months and 12 months. Minor changes were observed in all the measures; none of these changes were severe enough to be of great concern. No evidence was found to justify restriction of flying during INH administration, although the results of this study suggest that careful monitoring of patients taking INH is indicated.

71-23. **Effects of Isoniazid on performance II.** June 1971. *(ADA728823)*

By Mark A. Hofmann and Richard O. Nossman.

Seventeen aviators who converted from negative to positive on a tuberculosis tine test performed a variety of laboratory tests given before, during and after INH therapy. INH was administered prophylactically at dosage levels of 300 mg per day for 1 year. The tasks consisted of reaction time (auditory and visual), rotary pursuit tracking, mental multiplication, and digit span. The data did not indicate that the drug adversely affected performance on any of the tasks utilized.

71-24. **The testing of thermal protective clothing in a reproducible fuel fire environment, a feasibility study.** June 1971. *(AD729362)*

By John D. Albright, Francis S. Knox, III, David R. DuBois, and George M. Keiser.

This report sets forth the conceptual design for a facility intended for development and evaluation of thermal protective clothing in a reproducible fuel fire environment. The methods developed relate thermal characteristics of fabrics to biomedical aspects of burn prevention. A number of bioengineering problems are identified, the resolution of which is expensive and time consuming. It is concluded

that construction of the facility designed is technically feasible. Due to the magnitude and complexity of the bioengineering problems identified and because of advances in laboratory testing methods, however, construction of such a facility is not considered to be a prudent expenditure of public funds at this time. Operationally-oriented bioengineering/aeromedical evaluation of thermal protective clothing systems remains essential.

Fiscal Year 1972

72- 1. **Nystagmus responses during triangular waveforms of angular velocity the**
NAMRL **Y- and Z-axes.** July 1971. *(AD731380)*
1138

By Richard D. Gilson, Charles W. Stockwell, and Fred E. Guedry, Jr.

Nystagmus response parameters were estimated by a test procedure using short triangular waveforms of angular velocity. Mean estimates were determined as follows: (pi/delta = 15.5 seconds and K_n(0/delta) = 8.0 seconds for horizontal semicircular canals, and pi/delta = 6.8 seconds and K_n(0/delta) = 5.4 seconds for the vertical semicircular canals. The pi/delta values are consistent with results obtained by other methods. Values of K_n(0/delta) have not been heretofore assessed. Determination of the effects of stimulus distortion on the values of the response parameters and estimates of intersubject and intrasubject variability are included. Also included are nomograms that permit a simple and accurate method for calculating pi/delta and K_n(0/delta).

72- 2. **Effects of different alcohol dosages and display illumination on tracking**
NAMRL **performance during vestibular stimulation.** July 1971. *(AD732444)*
1140

By Richard D. Gilson, David J. Schroeder, William E. Collins, and Fred E. Guedry, Jr.

A previous investigation showed that alcohol impairs the ability to suppress vestibular nystagmus, thus degrading visual compensatory tracking performance during angular acceleration. Reduced display illumination, independently, also has been shown to degrade tracking performance during vestibular stimulation. The present study investigated the way in which low and moderate dosages of alcohol and two levels of instrument-display illumination combined to affect tracking performance a) in a static (no motion) environment, and b) in a dynamic (whole-body motion) environment. Mean blood-alcohol levels as low as 0.027 percent significantly ($p < .05$) decreased tracking performance during whole-body motion, yet caused little change in performance in a stationary environment. Impairment was much more pronounced with dim lighting (0.1 ft-L) than with bright lighting (1.0 ft-L). These results suggest that serious problems may even be encountered by the pilot who drinks lightly and who considers flying, especially at night.

72- 3. **Static comparison of vertical tape and vertical light emitting diode displays.** August 1971. *(AD730316)*

By Robert H. Schrimsher, Andrew S. Martin, Kurt E. Lidke, Mark A. Hofmann, Erwin G. Braun, John K. Crosley, Ronald G. Tabak, and Edgar C. White, Jr.

This study was performed in three parts. The first part consisted of comparing a prototype light emitting diode vertical display with a current vertical tape display, for reading speed and accuracy, under two viewing angles, three levels of illumination, and two time conditions. The results indicated that the 16 aviators (subjects) overestimated the LED instrument while the vertical tape instrument was underestimated. In addition, absolute errors in reading were greater for the LED display than they were for the vertical display. Time conditions and angles did not have a significant effect, while illumination level for the LEDs was of importance.

Part II consisted of a human factors facial design evaluation for one vertical tape display and four prototype LED displays. All displays were found to be deficient when compared to military standards and research recommendations.

Part III consisted of a photometric evaluation of the four LED displays. The results showed that these displays were unacceptable for viewing under high ambient light conditions and that gross luminance differences between individual diodes existed within the same display.

72- 4. **Orientation-error accidents in regular Army aircraft during Fiscal Year**
NAMRL **1968: Relative incidence and cost.** September 1971. *(AD735119)*
1143

By Jorma I. Niven, W. Carroll Hixson, and Emil Spezia.

This report is the second in a longitudinal series of reports dealing with the pilot disorientation/vertigo accident problem in Army fixed-wing and rotary-wing flight operations. Incidence and cost data presented for Fiscal Year 1968 include a total of 75 major and minor orientation-error accidents (26 of which were fatal), resulting in 91 fatalities, 75 nonfatal injuries, and an overall aircraft damage cost of $12,381,805. The contribution of rotary-wing accidents to these totals was 66 accidents (21 of which were fatal), resulting in 80 fatalities, 70 nonfatal injuries, and an overall aircraft damage cost of $9,077,065.

72- 5. **Orientation-error accidents in regular Army UH-1 aircraft during Fiscal**
NAMRL **Year 1968: Relative incidence and cost.** October 1971. *(AD735457)*
1145

By Jorma I. Niven, W. Carroll Hixson, and Emil Spezia.

This report is the second in a longitudinal series of reports dealing with the

magnitude of the pilot disorientation/vertigo accident problem in regular Army UH-1 helicopter operations. Incidence and cost data presented for Fiscal Year 1968 include a total of 53 major and minor orientation-error accidents (17 of which were fatal), resulting in 74 fatalities, 60 nonfatal injuries, and $8,224,607 aircraft damage.

72- 6. **Major orientation-error accidents in regular Army UH-1 aircraft during Fiscal Year 1968: Accident factors.** October 1971. *(AD738808)*
NAMRL
1147

By W. Carroll Hixson, Jorma I. Niven, and Emil Spezia.

This report is the second in a longitudinal series of reports dealing with the pilot disorientation/vertigo problem in regular Army UH-1 helicopter operations. Individual case history data extracted from the USABAAR master aircraft accident files are presented on 52 major orientation-error accidents that occurred in UH-1 aircraft during Fiscal Year 1968. Summary data listings involving a variety of operational and pilot-related accident factors are presented for each of the cases. The listings are arranged to distinguish between those factors and events present before take-off; i.e., the initial conditions associated with a given accident, and those which occurred or were manifested during the actual airborne phase of the accident.

72- 7. **Dynamic and crashworthy evaluation of UH-1B, C, D, H medical attendant's seat.** January 1972. *(AD737197)*

By Errol B. Barber, Stanley C. Knapp, G. E. Tornquist, S. P. Desjardins, and Felix T. Aguilar.

The challenge was to evaluate the crashworthiness of the UH-1 medical attendant's seat and investigate the feasibility of modifications to improve the seat and its restraint system. This report is a record of USAARL's involvement, from researching the background to achieve a proper direction for study, through accident statistics, stress analysis, dynamic test program, reduction of data, interpretation, conclusion, and finally, feasible recommendations.

The seat was found to be completely uncrashworthy and a direct contributor to serious injuries to its occupants mostly to the upper torso and head because of poor occupant restraint. Its construction and manufacture did not meet all of the design criteria of military seat specifications. The dynamic tests of the seat demonstrated that with the addition of the inertia reel, shoulder harness, and attachment of the lap belt to the floor, a seat occupant could be satisfactorily restrained despite serious seat failure from a crash. The proposed modifications in kit form will provide the seat's occupant with the greatest increase in safety and retention, should crash occur, for the lowest dollar investment and "down time" required for its installation. This seat should not be considered for incorporation into any future military aircraft.

72- 8. **Real-ear sound attenuation characteristics of sixty-three ear protection devices.**
(This report was not published.)

72- 9. **Studies of fluorometric assay procedures for Lysergic Acid Diethylamide.** February 1972. *(AD737671)*

By Peter J. Kasvinsky.

Studies of the available fluorometric assay procedures for LSD-25 are described for possible clinical application. Variability of plasma 'blank' background fluorescence values were found to prohibit the use of standard fluorometric procedures without modification. A little known fluorometric procedure is described, which minimizes this problem and maintains the sensitivity of the assay at the subnanogram level.

72-10. **Evaluation of the Grumman MK-J5D ejection seat in respect to spinal alignment.** February 1972. *(AD893668L)*

By Burton H. Kaplan.

Three aviators from the U.S. Army Aviation Test Board were selected because of their representative anthropometric sitting heights and seated in the Grumman ejection seat, Type MK-J5D. Spinal alignments were evaluated by radiographic analysis in each of two firing positions. Under static conditions, no significant intra-subject variations were noted in spinal alignment between the primary face curtain or secondary "D" ring firing position. Thoracic flexion was found to be reduced in the MK-J5D when compared to the MK-J5A, B ejection seat. The 5th and 95th percentile sitting height crewmembers appear to be more predisposed to vertebral fracture than the 40th percentile due to seat back contour design. The MK-J5D was subjectively more comfortable than the MK-J5A, B ejection seats when evaluated under optimal static conditions.

72-11. **Helicopter in-flight monitoring system.** March 1972. *(AD745118)*

By Harlie W. Huffman, Mark A. Hofmann, and Michael R. Sleeter.

This paper deals with the description of a helicopter in-flight monitoring system. This system measures and records in real time, all six degrees of freedom of the aircraft, cyclic, collective, and pedal inputs as well as some status values.

72-12. **Vietnam returnee survey.** March 1972. *(AD742665)*

By Kurt E. Lidke, Mark A. Hofmann, and Andrew S. Martin.

This paper presents some results of a questionnaire given to 300 Army aviators who served in the Republic of Vietnam. The questions analyzed were primarily those concerned with work patterns, physical conditions, medical care, groundings, and accidents.

72-13. **Orientation-error accidents in regular Army aircraft during Fiscal Year**
NAMRL **1969: Relative incidence and cost.** April 1972. *(AD743483)*
1161

By W. Carroll Hixson, Jorma I. Niven, and Emil Spezia.

This report is the third in a longitudinal series of reports dealing with the pilot disorientation/vertigo accident problem in Army fixed-wing and rotary-wing flight operations. Incidence and cost data presented for Fiscal Year 1969 include a total of 71 major and minor orientation-error accidents (22 of which were fatal), resulting in 51 fatalities, 79 nonfatal injuries, and an overall aircraft damage of $11,928,660. The contribution of rotary-wing accidents to these totals was 65 accidents (20 of which were fatal), resulting in 46 fatalities, 78 nonfatal injuries, and $11,724,852 aircraft damage.

72-14. **Differential velocity and time prediction of motion.** April 1972. *(AD745119)*

By Kent A. Kimball, Mark A. Hofmann, and Richard O. Nossman.

The investigation examined the effects of differential target velocity, horizontal or vertical plane conditions and air traffic controller experience on the intersection time estimation accuracy of two converging targets. Performance accuracy on this task was not significantly affected by horizontal or vertical conditions nor by air traffic controller experience. However, accuracy in magnitude and direction was found to significantly vary as a function of cursor speed with slower speeds producing the poorer performance. A differential effect for various speed combinations also was noted. Estimation accuracy on the slowest cursor speed when paired with the two faster speeds was decreased while accuracy on the intermediate speed was degraded when combined with either slower or faster speeds. Estimations on the fastest speed were not affected by differential pairings.

72-15. **Improving U.S. Army aircraft propeller and tail rotor conspicuity with paint.** May 1972. *(AD744453)*

By John K. Crosley, Ronald G. Tabak, Erwin G. Braun, and Robert W. Bailey.

Rotating propellers and tail rotors represent a potential hazard for personnel while aircraft are on the ground. This study was conducted to ascertain if rotating blades could be visually detected more easily by the judicious application of paint. A total of 22 observers rated nine different paint schemes for effectiveness. The results showed that 1) the two schemes presently being used on Army aircraft rated the poorest of all those investigated, and 2) the most conspicuous scheme was one which had (from the tip toward the hub) a four-inch section painted red-orange fluorescent, with the remaining surface divided into thirds and painted alternately flat black and gloss white. The black and white sections of the other half of the blade were reversed to provide a nonconcentric pattern.

72-16. **Orientation-error accidents in regular Army UH-1 aircraft during Fiscal**
NAMRL **Year 1969: Relative incidence and cost.** August 1972. *(ADA017665)*
1163

By W. Carroll Hixson, Jorma I. Niven, and Emil Spezia.

This report is the third in a longitudinal series of reports dealing with the magnitude of the pilot disorientation/vertigo accident problem in regular Army UH-1 helicopter operations. Incidence and cost data presented for Fiscal Year 1969 include a total of 46 major and minor orientation-error accidents (16 of which were fatal), resulting in 39 fatalities, 67 nonfatal injuries, and $8,130,297 aircraft damage.

Fiscal Year 1973

73- 1. **Human head and neck response to impact acceleration.** August 1972.
NAMRL *(AD747988)*
Mono-
graph By Channing L. Ewing and Daniel J. Thomas.
21

A methodical investigation and measurement of human dynamic response to impact acceleration was conducted as a Joint Army-Navy-Wayne State University investigation. Linear accelerations were measured on the top of the head, at the mouth, and at the base of the neck. Angular velocity was also measured at the base of the neck and at the mouth. A redundant photographic system was used for validation. All data were collected in computer-compatible format and data process-

ing was by digital computer. Selected data analysis on 41 representative human runs involving 12 subjects of the 236 human runs completed to date are presented.

Description of the experimental design data collection and processing is given in detail. Ancillary research efforts in support of the program also are described.

Representative plots of human kinematic response are presented, discussed, and compared. Repeatability and quality control plots also are presented. There are a total of 755 computer drawn plots illustrating a characteristic, repeatable response of human subjects to impact acceleration.

73- 2. **Major orientation-error accidents in regular Army UH-1 aircraft during Fiscal Year 1969: Accident factors.** October 1972. *(AD753208)*
NAMRL 1169

By W. Carroll Hixson, Jorma I. Niven, and Emil Spezia.

This report is the third in a longitudinal series of reports dealing with the pilot disorientation/vertigo accident problem in regular Army UH-1 helicopter operations. Individual case history data extracted from the USABAAR master aircraft accident files are presented on 44 major orientation-error accidents that occurred in UH-1 aircraft during Fiscal Year 1969.

Summary data listings involving a variety of operational and pilot-related accident factors are presented for each of the 44 cases. The listings are arranged to distinguish between those factors and events present before takeoff, i.e., the initial conditions associated with a given accident, and those that occurred or were manifested during the actual airborne phase of the accident flight.

73- 3. **Development of a Bio-Pac for cardiac evaluation of porcine research animals.** August 1972. *(AD750100)*

By Thomas L. Wachtel, G. R. McCahan, Jr., and Lynn A. Alford.

This report describes a technique for implanting central venous and aortic catheters via the jugular veins and carotid arteries in miniature swine and the device designed and utilized to protect these catheters. Such indwelling catheters were easily maintained for 14 days in unrestrained, free roaming pigs while serial blood samples, pressure recording, electrocardiographic monitoring, and cardiac output measuring were conducted and infusion of precise amounts of fluids or drugs administered.

73- 4. **The contractile response of the spleen of miniature swine to intra-arterial infusion of epinephrine.** September 1972. *(ADA032805)*

By Thomas L. Wachtel, G. R. McCahan, Jr., and William M. McPherson.

The spleen of miniature swine is a blood organ which contracts with intra-arterial injection of epinephrine (and presumably other stressful stimuli) and thus autotransfuses the animal. We recommend the removal of the spleen of miniature swine prior to use of this animal for any shock studies.

73- 5. **Determining the surface areas of miniature swine and domestic swine by geometric design--a comparative study.** October 1972. *(AD757600)*

By Thomas L. Wachtel, G. R. McCahan, Jr., William I. Watson, and Michael Gorman.

The geometric design method provides an accurate means of deriving the total body surface area (TBSA) of miniature swine and also the percentage of TBSA for a given area. The formula for TBSA derived for domestic swine and the "Rules of 5" are not applicable to miniature swine. The equation S equals 0.121 W.575 provides a more accurate, quick assessment of TBSA of miniature swine.

73- 6. **Anesthesia or immobilization of domestic and miniature swine: Methods and some problems.** December 1972. *(ADA955914)*

By G. R. McCahan, Jr., and Thomas L. Wachtel.

Anesthetic procedures, care, and handling of both miniature swine and domestic swine have been outlined. Practical techniques to overcome some of the former difficulties associated with endotracheal intubation are described. Atropine and halothane were considered the best agents.

73- 7. **Bump protection evaluation of the Standard T56-6 and prototype DH-132 combat vehicle crewman's helmet.** January 1973. *(ADB015273L)*

By Burton H. Kaplan, Thomas D. Casey, Stanley C. Knapp, Robert K. Shirck, and Richard Tucker.

Prototypes of the Gentex Combat Vehicle Crewman's Helmet Model DH-132 and Standard Combat Vehicle Crewman's Helmet T56-6 were evaluated for their ability to provide bump protection. All prototype DH-132 helmets proved to be superior to the standard T56-6 helmets. It was concluded that the standard T56-6 helmet represented an obsolete design that was unsuitable for modification. The

first prototype (DH-132-1) failed to meet the technical performance criteria of the material need document. It was found that the fiberglass layers in the helmet shell (DH-132-1) were unevenly distributed. This resulted in the presence of higher load concentrations over small areas of the inner liner. In order to meet the bump criteria, USAARL recommended that the fiberglass layup be uniform and that a thicker inner liner be incorporated. This was accomplished in the second prototype [DH-132-2 (5/8")] which did meet the military need criteria and current accepted biomedical standards. This helmet is recommended to be classified as Standard A.

73- 8. **Real-ear attenuation characteristics of the DH-132 helmet for armored vehicle crewmen.** February 1973. *(ADA032806)*

By Robert T. Camp, Jr., Robert W. Bailey, Ben T. Mozo, Gordon A. Schott, Rohinton N. Guzdar, and Timothy M. Hinkel.

The U.S. Army Aeromedical Research Laboratory was requested by the Preventive Medicine Division of The Office of The Surgeon General to test "off-the-shelf" helmets that would be suitable for the replacement of the standard T56-6 CVC helmet. Audiometric data taken from samples of tank crewmen revealed hearing losses which indicated that there is an urgent need for the development of a helmet that would protect against the adverse acoustic environments associated with tank operations. Previous evaluation by real-ear tests of sound attenuation established the T56-6 to be an inadequate acoustic protective device for armored vehicle crewmen.

Three "off-the-shelf" helmets were tested and recommended as suitable for consideration as a possible replacement for the standard CVC helmet. The DH-132 was identified by the Armor Center as their choice of the three presented as most appropriate for the armor environment.

A material need (MN) document was prepared and staffed to procure the DH-132. The first group procured for engineering and service test DH-132-1 was found less efficient than the original DH-132. This identified deficiency was corrected in a second prototype DH-132-2. Data in this report confirms the DH-132-2 meeting or exceeding all acoustic attenuation requirements of the MN and medically acceptable as an acoustic protector for armored vehicle crewmen. Therefore, type classification Standard A is recommended for the DH-132-2 helmet.

73- 9. **A comparison of methods of preparing porcine skin for bioassay of thermal injury.** March 1973. *(ADA001684)*

By Thomas L. Wachtel and G. R. McCahan, Jr.

Clipping, shaving, and depilation methods of hair removal were evaluated on

porcine skin in preparation for its as a bioassay substrate for thermal injury. Each method provides distinct advantages and disadvantages. Criteria for selecting the proper methodology are identified for a bioassay for thermal substrate injury studies.

73-10. **Rectal temperatures of miniature and domestic swine.** March 1973. (This report was not published.)

73-11. **Military anti-shock trouser.** April 1973. *(AD760527)*

By Burton H. Kaplan.

Acute hypovolemia may occur with blood loss, fluid shifts within tissue compartments and vasodilatation. Prehospital treatment has consisted of positioning patient, control of environment, oxygen administration, wound dressing, and more recently, intravenous fluid administration and/or vasopressors. Few studies demonstrate on-site efficacy of intravenous fluid therapy in terms of time factors, quantities administered, and effect periods. Even more controversial are the effects of pressor agents in such states as a primary method of choice.

The U.S. Army Aeromedical Research Laboratory at Fort Rucker, Alabama, has produced an antishock garment of novel design which is extremely fast and easy to apply, fits nearly all size and body configurations, and is extremely effective. It has been evaluated by City of Miami Fire Rescue units in a series of trauma cases involving lower extremities, pelvis, and abdomen. It results in prompt return of vital signs in the patient where neither pulse nor blood pressure were obtainable. The time of application and return of vital signs has been less than 3 minutes in all cases.

Although intravenous fluids also were started, the amount administered was less than 100 cc in each case cited. The device enables some degree of autotransfusion from each lower extremity, while at the same time limiting the circulation to the lower half of the body.

Its effect in states of cardiac arrest remains to be defined. By its shunting action, it might be extremely beneficial by diverting marginal cardiac output to the upper body and brain. The device is shown and cases regarding its use are presented.

73-12. **Porcine burn shock: Development of a reliable model and response to sodium, water, and plasma loads administered for resuscitation.** June 1973. *(ADA001685)*

By Thomas L. Wachtel and G. R. McCahan, Jr.

Miniature swine are a sensitive and responsive animal for the study of burn shock resuscitation. The sodium loads requisite for resuscitation of burned swine can exert roughly the same effects when administered in volumes of from 25 to 50 percent less than those commonly used clinically. Sodium excretion is more dependent upon the sodium load than upon the concentration of the saline solution. Plasma administration has no demonstrable resuscitative effect over and above that provided by the sodium and volume given in this model.

73-13. **Bump protection evaluation of the Standard P/N 791 Combat Vehicle Crewman's Helmet.** May 1973. *(AD762154)*

By Thomas D. Casey, Robert K. Shirck, and Richard Tucker.

A prototype of the Sierra Combat Vehicle Crewman's Helmet model P/N 791 was evaluated for its ability to provide bump protection. The P/N 791 failed to meet the technical performance criteria of the materiel need document.

73-14. **Real-ear sound attenuation characteristics of the Sierra P/N 791 AVC Helmet.** June 1973. *(AD762565)*

By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Gordon A. Schott, Rohinton N. Guzdar, and Timothy M. Hinkel.

The U.S. Army Aeromedical Research Laboratory was requested by the Preventive Medicine Division of the Office of The Surgeon General to test "off-the-shelf" helmets that would be suitable for the replacement of the standard T56-6 CVC helmet. Previous evaluation by real-ear tests of sound attenuation established the T56-6 to be an inadequate hearing protector for armored vehicle crewmen.

Three "off-the-shelf" helmets were tested and recommended as suitable for consideration as a possible replacement for the standard CVC helmet. The DH-132 was identified by the Armor Center as their choice of the three presented helmets as being most appropriate for the armor environment. Recently another helmet, the Sierra P/N 791 AVC helmet, has been submitted for consideration as a second helmet for armored vehicle crewmen.

The real-ear attenuation test results show that the Sierra helmet significantly failed the attenuation tests and therefore did not meet the attenuation requirements

established by The Surgeon General. The Sierra helmet in its present configuration is not acceptable as a hearing protector for U.S. Army tank personnel.

73-15. **Study of flight environment effects on helicopter gunner.** June 1963. *(AD766224)*

By Carl Larson, Edward Wells, and Burton H. Kaplan.

Disorientation periods of a helicopter gunner in the conduct of his task during a planned flight profile were investigated through the use of a computerized mathematical model of the vestibular system. Flight attitude and crewman seat change data were used as input to the model and crewman nystagmus rates and perceived angular sensations were predicted. These output data then were compared to actual on-board flight observations of crewman status and well being. The mathematical model was found to accurately predict periods of disorientation that coincided with those observed and were manifested by either excess nystagmus rates, perceived sensations of motion, or a combination of both. Rapid changes in seat angle were attributed as the primary cause of disorientation with vehicle attitude changes cross-coupled with seat angle changes, producing a secondary effect.

73-16. **Preliminary evaluation of portable aviation oxygen systems.** July 1973. *(AD776348)*

By Jay C. Bisgard, Roderick J. McNeil, and Frank S. Pettyjohn.

The problem was to determine the requirements for portable aviation oxygen systems during Army high altitude rescue and medical evaluation missions, and then to determine the necessity for R&D efforts by evaluating the potential of currently available system components to fulfill the identified requirements. This preliminary report is a record of USAARL's involvement in the area of Army aviation oxygen systems to include researching the background to achieve a proper direction for study, selection of promising systems for altitude chamber evaluation, study results, conclusions, and feasible recommendations. It was found that immediate Army requirements can be satisfied by currently available military and commercial oxygen system components. Prior to procurement approval, however, the recommended systems should be obtained for field testing by three operational rescue units, the results of which will provide the basis for the final report of this study.

Although an R&D effort is not absolutely required, a short term effort would be desirable if limited to modification of prototype components to maximize their potentials while decreasing their ultimate costs.

Fiscal Year 1974

74- 1. **Chronic transdermal electrodes.** August 1973. *(AD772968)*

By William P. Schane and Thomas L. Wachtel.

Five-tenths (0.5) mm diameter (20 mil) 80 percent platinum--20 percent iridium wire was used to make chronically implanted transcutaneous electrodes for use in 14 subjects over a 19-week period. The techniques of implantation and management are described. The advantages and disadvantages of the implanted electrodes are discussed. Suggestions are made to improve future application.

74- 2. **Army autorotation accidents: Fiscal Years 70-72.** August 1973. *(AD766225)*

By Kent A. Kimball, Donald F. Harden, and Mark A. Hofmann.

This report is a review of autorotation accidents occurring during the Fiscal Years 1970 through 1972. This work presents information on these accidents and their relation to total rotary-wing accidents, accident rates, geographical areas, specific aircraft, costs, fatalities, and injuries. Data delineating the causative factors of these accidents also are presented and discussed.

74- 3. **Orientation-error accidents in regular Army aircraft during Fiscal Year**
NAMRL **1970: Relative incidence and cost.** August 1973. *(AD767028)*
1188

By Jorma I. Niven, W. Carroll Hixson, and Emil Spezia.

This report is the fourth in a longitudinal series of reports dealing with the pilot disorientation/vertigo accident problem in Army fixed-wing and rotary-wing flight operations. Incidence and cost data presented for Fiscal Year 1970 include a total of 81 major and minor orientation-error accidents (25 of which were fatal), resulting in 80 fatalities, 104 nonfatal injuries, and an overall aircraft damage cost of $19,355,689. The contribution of rotary-wing accidents to this total was 75 accidents (24 of which were fatal), resulting in 79 fatalities, 98 nonfatal injuries, and an overall aircraft damage cost of $17,060,490.

74- 4. **Parachute escape from helicopters.** August 1973. *(AD772970)*

By William P. Schane.

Experimental evidence shows that a parachutist experiences no major difficulty in achieving vertical and horizontal separation from an autorotating helicopter. At

high rates of descent, there is a 0.5-0.75 second delay after exit before expected separation begins.

74- 5. **Orientation-error accidents in regular Army UH-1 aircraft during Fiscal**
NAMRL **Year 1970: Relative incidence cost.** September 1973. *(AD768307)*
1192

By Jorma I. Niven, W. Carroll Hixson, and Emil Spezia.

This report is the fourth in a longitudinal series of reports dealing with the magnitude of the pilot disorientation/vertigo accident problem in regular Army UH-1 helicopter operations. Incidence and cost data presented for Fiscal Year 1970 include a total of 43 major and minor orientation-error accidents (17 of which were fatal), resulting in 66 fatalities, 67 nonfatal injuries, and a total UH-1 aircraft damage cost of $7,706,191.

74- 6. **The effects of initial spinal configuration on pilot ejection.** October 1973. *(AD780847)*

By Y. King Liu, Uwe R. Pontius, and Ronald R. Hosey.

The effects of initial spinal alignment on the location and magnitude of maximum vertebral stress during ejection were studied using the Orne-Liu discrete parameter model of the spine. Face curtain, shoulder harness, and scat back restraints were added to the model as linear springs. Spinal alignment data used were from x-rays of 5th, 40th, and 95th, percentile (sitting height) men seated in the MK-J5(D) ejection seat under static conditions. Maximum normal stresses were shown to occur at L1(5th), T12(40th) and T9(95th) with face curtain and shoulder harness restraint. These locations correspond almost exactly to the predictions of injury based on static observations of the curvature of the initial configuration of the pilot's spine. Inclusion of posterior-anterior seat back support decreased maximum stresses as did the use of an improved lumbar pad which placed the lower spinal column in extension. Failure to utilize the face curtain restraint gave rise to large normal stresses in the upper thoracic column. Results indicated that a state of nearly uniform axial stress exists in the column during ejection and thus the location of maximum bending stress dictates the spinal location of the maximum normal stress. Hence, initial spinal alignment, in terms of the curvature of the column, is a major determinant of the location and magnitude of maximum normal stress for a given set of restraints.

74- 7. **Aviation visual performance in the UH-1H, Study I.** October 1973.
(ADA032857)

By Thomas L. Frezell, Mark A. Hofmann, and Richard E. Oliver.

This study monitored, via the corneal reflection technique, visual performance of Army aviators while flying a number of maneuvers in a UH-1H. Visual performance, to include time and transition information, was gathered over 13 cockpit areas. In addition to the objective recordings, subjective assessments by the aviators with regard to their visual performance also were attained. Results acquired by both techniques are provided.

74- 8. **Instrument flight preference and field dependence.** January 1974.
(AD776373)

By Eric R. George and Mark A. Hofmann.

This research investigated the possible relationship between field dependence-independence, as measured by the Rod and Frame Test (RFT) and aviator attitudes regarding IFR flight. Degree of aviator preference for actual instrument flight (determined by questionnaire and personal interview) served as a basis for dividing the aviator sample (43 pilots) into high and low preference groups. These groups were examined relative to three field dependence measures derived from RFT performance. The IFR preference group factor did not contribute significantly to the variation in RFT performance either singularly or in interaction with other factors, such as body attitude or visual field.

In addition, demographic data of both subject groups were reduced and examined. A positive correlation was found between instrument flight experience and total flight hours for the IFR high preference aviators only; no significant differences were demonstrated for other variables.

74- 9. **Static evaluation of absolute altimeter display sign---study I.** February 1974.
(AD776345)

By Thomas L. Frezell, Donald R. Harden, Paul D. Hunt, and Mark A. Hofmann.

Six absolute altimeter display designs were evaluated in the static mode. Performance was measured with respect to subjects' reading accuracy, speed and preference. The subjects consisted of experienced Army aviators and nonflying college students. The results showed a significant difference between display types as well as between aviators and students.

74-10. **Soft (hydrophilic) contact lenses in U.S. Army aviation: An investigative study of the Bausch and Lomb Softlens™.** March 1974. *(AD776353)*

By John K. Crosley, Erwin G. Braun, and Robert W. Bailey.

The use of standard acrylic or "hard" contact lenses has been relatively unsuccessful in the military aviation environment, particularly when worn by personnel flying rotary-wing aircraft. The purpose of this study was to evaluate the applicability of one type of hydrophilic lens to U.S. Army aviation. Nineteen volunteer helicopter pilots served as subjects and three specific areas were investigated. These were: (1) Clinical procedures, (2) foreign body involvement, and (3) the effect of extended (72 hours) continuous wear. The results indicate that the Soflens™ offers certain advantages over acrylic lenses for this specialized application. There were, however, distinct problems encountered which may be lessened with the introduction of new lens materials and asepticizing techniques.

74-11. **Individual differences in vestibular information as a predictor of motion**
NAMRL **disturbances susceptibility.** April 1974. *(AD781881)*
1200

By H. J. Moore and Fred E. Guedry, Jr.

Certain facts suggest that motion disturbances may be related to the amount of vestibular information contributing to sensory conflict. Individual differences in motion disturbance susceptibility might, therefore, correlate positively with differential accessibility of vestibular sensory information to the spatial perceptual process. The results of two experiments, while not inconsistent with this hypothesis, did not demonstrate a relationship between a vestibular response variance measure and motion disturbance susceptibility at the conventional significance level. The test-retest reliability of the response variance measure was not found to be favorable. The slope of the vestibular stimulus-response relationship was not found to predict motion disturbance susceptibility.

74-12. **Major orientation-error accidents in regular Army UH-1 aircraft during**
NAMRL **FY 1970: Accident factors.** June 1974. *(ADA001710)*
1202

By W. Carroll Hixson, Jorma I. Niven, and Emil Spezia.

This report is the fourth in a longitudinal series of reports dealing with the pilot disorientation/vertigo problem in regular Army UH-1 helicopter operations. Individual case history data from the USAAAVS master aircraft accident files are presented on major orientation-error accidents that occurred in UH-1 aircraft during Fiscal Year 1970. Summary data listings involving a variety of operational and pilot-related accident factors are presented for each of the 42 cases. The listings are arranged to distinguish between those factors and events present before takeoff, i.e.,

the initial conditions associated with a given accident, and those which occurred or were manifested during the actual airborne phase of the accident flight.

Fiscal Year 1975

75- 1. **Personality aspects of pilot error accident involvement.** July 1974. *(AD782976)*

By Michael G. Sanders, Mark A. Hofmann, Paul D. Hunt, and Allen C. Snow, Jr.

The consistently high frequency of pilot error accidents in both military and civilian aviation programs does much to support exploratory research which might help alleviate the problem. Cattell's Sixteen Personality Factor Questionnaire (16 PF) and a dynamic decision making task (under risk) were given to 51 Army aviators. Accident files were then examined in order to classify the aviators as to their prior pilot error accident involvement. Stepwise discrimination analyses revealed that the decision making task scores were unrelated to the pilot error accident groupings while the 16 PF scores were able to correctly classify 86 percent of the aviators as to whether or not they had been previously listed as a cause factor in a military aviation accident.

75- 2. **Some effects of alcohol on various aspects of oculomotor controls.** August
NAMRL 1974. *(ADA000079)*
1206

By Fred E. Guedry, Jr., Richard D. Gilson, David J. Schroeder, and William E. Collins.

Recent studies have shown that alcohol interferes with visual control of vestibular nystagmus. The present study was designed to assess three partially independent systems of oculomotor control. Performance on three tasks was measured before and after mild alcohol dosage. One task involved visual suppression of vestibular nystagmus; a second involved smooth oculomotor tracking of a moving target, and a third required repetitive rapid voluntary shifts in gaze. Oculomotor control was degraded on the first two tasks with recovery toward the initial performance level 4 hours after drinking. Performance on the third task was not obviously degraded, although it is possible that improvement with practice was retarded. Results are discussed in terms of neurological systems involved and kinds of flight tasks potentially affected.

75- 3. **Aviator performance during local area, low-level and nap-of-the-earth flight.** September 1974. *(ADA001683)*

By Kent A. Kimball, Thomas L. Frezell, Mark A. Hofmann, and Allen C. Snow, Jr.

This paper presents baseline data concerning aviator performance and aircraft state variables during local area, low-level and nap-of-the-earth flights. Further, information is provided concerning differences in aviator control inputs per unit of time across the three profiles. From the data, it is evident that NOE flight places more demands on both crews and aircraft than the other two types of flight.

75- 4. **Review of the U.S. Army Aeromedical Research Laboratory Conference on Aeromedical Evacuation, 15-16 January 1974.** August 1974. *(ADA001544)*

By Frank S. Pettyjohn. Contributor Eugene L. Nagel.

The U.S. Army Aeromedical Research Laboratory has supported the helicopter medical evacuation mission throughout its rapid growth. The concept of dedicated evacuation helicopters and crews has been well proven during the Vietnam conflict. Concurrent with this development has been the rapid emergence of the civilian emergency medical services within the continental United States. The utilization of the military helicopter in a joint role with the civilian community, the Military Assistance to Safety and Traffic, as well as in its combat evacuation role requires combined emphasis and upgrading of medical equipment and procedures.

This conference represents a unique approach to the problems of maintaining pace with the rapid developing field of aeromedical evacuation. The informal seminar structure provided the helicopter unit, the user, an opportunity to discuss problem areas of medical and operational needs with the U.S. Army Aeromedical Research Laboratory, the developer. In addition, this conference represented a first in bringing together operational helicopter unit personnel from both the U.S. Army and the U.S. Air Force to discuss common problems.

The concepts, ideas, and suggestions presented should ensure the continued improvement of medical equipment and techniques to provide the highest degree of medical care to the U.S. Military Forces.

75- 5. **The in vivo dynamic material properties of the canine spinal cord: A feasibility study.** August 1974. *(ADA002062)*

By Y. King Liu, K. B. Chandran, and William C. Van Bushirk.

A study was completed which showed the feasibility of determining the in vivo

dynamic material properties of the spinal cord in mongrel dogs. In the initial phase, sinusoidal pressure waves were induced on a fluid-filled thin-walled penrose surgical drainage tube and the wave length was monitored by two micropressure transducers. The wave speed obtained from these measurements was inserted into the Mons-Korteweg relation to determine the Young's modulus for the penrose tubing. The value obtained for the modulus was in excellent agreement with values cited in the literature. In the second phase, a portion of the spinal cords of three dogs was exposed by a laminectomy and then the cords subjected to an identical wave propagation method of procedure as determined in the initial phase. It was important to block the spinal cord jerk reflex by a local anesthetic, Xylocaine™, distal to the test section of the cord before the start of the experiment. Thus, the surgical tools, electromechanical equipment and accessories, and the method of procedure required for the successful determination of some of the in vivo dynamic material properties of the spinal cord of dogs was established.

75- 6. **Orientation-error accidents in regular Army aircraft during Fiscal Year**
NAMRL **1971: Relative incidence and cost.** November 1974. *(ADA004189)*
1209

By W. Carroll Hixson and Emil Spezia.

This report is the fifth in a longitudinal series of reports dealing with the pilot disorientation/vertigo accident problem in Army fixed-wing and rotary-wing flight operations. Incidence and cost data presented for Fiscal Year 1971 include a total of 50 major and minor orientation-error accidents (25 of which were fatal), resulting in 65 fatalities, 67 nonfatal injuries, and an overall aircraft damage cost of $11,404,119. The contribution of rotary-wing accidents to this total was 47 accidents (23 of which were fatal), resulting in 62 fatalities, 67 nonfatal injuries, and an overall aircraft damage cost of $11,191,377.

75- 7. **The brief vestibular disorientation test as an assessment tool for non-**
NAMRL **pilot aviation personnel.** October 1974. *(ADA004963)*
1210

By Rosalie K. Ambler and Fred E. Guedry, Jr.

Past research has demonstrated the value of the Brief Vestibular Disorientation Test (BVDT) as a screening tool for student pilots. This study is concerned with the extension of this technique for use in assessing the potential naval flight officer (NFO).

The rater BVDT procedure was used here, and in addition, a performance task involving a short-term memory task in the auditory mode was introduced in order to measure performance decrement. Representative groups of entering NFO students first were administered the performance task under the exact conditions of the previous BVDT procedure, but without rotation. After a 2-minute rest period, the

procedure was repeated with rotation. Observer assessments were made during this rotation sequence. The results indicate that those students who later failed NFO training exhibited greater performance decrement under rotary conditions as compared to static than did successful students. Rater-type BVDT scores also indicated slightly greater sensitivity (.07 level of significance) to the vestibular stimulus for the failures than for the successes. It was concluded that this technique is of potential value in screening NFOs.

75- 8. **Oxygen toxicity in the mammalian brain.** December 1974. *(ADA003229)*

By Dennis A. Baeyens and Joseph O. Bonnett.

The lactate dehydrogenase (LDH) activity of mouse brain homogentes was examined after exposure to hyperbaric oxygen (5763.8 mm Hg PO_2) and compared to room air controls (158.8 mm Hg PO_2). The effect of reduced glutathione on LDH activity after hyperbaric oxygen exposure was also examined. The activity of LDH after treatment with hyperbaric oxygen was significantly diminished when compared with controls. In the presence of reduced glutathione, homogenates exposed to hyperbaric oxygen demonstrated higher activity than did homogenates incubated without glutathione. It is concluded that oxygen induced inhibition occurs through the oxidation of essential free sulfhydryl groups and that this oxidation can either be prevented by reduced glutathione or the disulfide bridges may be reduced to free sulfhydryl groups by the glutathione after oxidation.

75- 9. **Evaluation of proposed electroplated HGU-4/P frames.** February 1975. *(ADA006121)*

By Roger W. Wiley, Frank S. Pettyjohn, and David D. Glick.

A gold electroplated frame has been recommended to replace the standard gold-filled aviator frame. Since the proposed frame contains a nickel-silver based metal, the frame was evaluated under field and laboratory conditions at the US Army Aeromedical Research Laboratory. Of the 18 subjects who wore the test frames for 3 months, one subject, an aviator, developed a mild dermatitis along the frontal and supraorbital portion of the face. Chemical analysis indicated "free" nickel in sufficient quantity to cause a reaction from nickel-sensitive individuals. This study has shown that some skin reaction can be expected from a small percentage of wearers if the gold electroplated frame replaces the gold-filled frame.

75-10. **Oxygen induced inhibition of mouse brain lactate dehydrogenase.** February 1975. *(ADA007144)*

By Dennis A. Baeyens.

The lactate dehydrogenase (LDH) activity of mouse brain homogenates was examined after exposure to hyperbaric oxygen (5763.8 mm Hg PO_2) and compared to room air controls (158.8 mm Hg PO_2). The effect of reduced glutathione on LDH activity after hyperbaric oxygen exposure also was examined. The activity of LDH after treatment with hyperbaric oxygen was significantly diminished when compared with controls. In the presence of reduced glutathione, homogenates exposed to hyperbaric oxygen demonstrated higher activity than did homogenates incubated without glutathione. It is concluded that oxygen induced inhibition occurs through the oxidation of essential free sulfhydryl groups and that this oxidation can either be prevented by reduced glutathione or the disulfide bridges may be reduced to free sulfhydryl groups by the glutathione after oxidation.

75-11. **Aviation visual performance in UH-1, study II.** March 1975. *(ADA007812)*

By Thomas L. Frezell, Mark A. Hofmann, Allen C. Snow, Jr., and Richard P McNutt.

This study monitored, via the corneal reflection technique, visual performance of Army aviators while flying incline maneuvers in a UH-1 helicopter. Visual performance, to include time and transition information, was gathered over 13 sectors. In addition to visual data, performance measurements were recorded simultaneously on an incremental digital recorder. Results acquired by both techniques are provided.

75-12. **Development of a prototype experimental plan to evaluate stabilized optical viewing devices: I. In-flight measurement of visual acuity.** April 1975. *(ADA011244)*
NAMRL 1213

By David D. Glick, Roger W. Wiley, Fred E. Guedry, Jr., W. Carroll Hixson, and Joel W. Norman.

An improved XM-76 stabilized viewing device was tested in a scout helicopter flight scenario. Target acquisition performance was significantly correlated with the airsickness ratings of an on-board experimenter. Since there was no significant difference between the magnitude of the symptoms observed when the device was stabilized and the magnitude when caged, the stabilization feature proper could not be identified as a problem source. Parts II and III of the report (in preparation) will deal with in-flight measures of airsickness potential and the laboratory evaluation of individual susceptibility to airsickness respectively.

75-13. **Communicating during terrain flight.** March 1975. *(ADA009336)*

By Michael G. Sanders, Mark A. Hofmann, Donald F. Harden, and Thomas L. Frezell.

Safe and efficient terrain flight requires that the copilot or navigator give verbal navigation instructions that allow the pilot to respond quickly and effectively with minimum confusion and head-in-cockpit time. The intracockpit communications of 47 nap-of-the-earth (NOE) training flights were tape recorded. NOE communication questionnaires were developed and administered to 60 student pilots and 74 instructor pilots. Analysis of the tapes and questionnaire data indicated that the crewmembers were spending 30.1 percent of their time in communication concerning navigation. Analysis of the tape recordings also indicated that new student pilot (SP) flight crews exhibited a greater density of communication (t equals 10.07, df equals 45, $p < .05$) than did the SP flight crews that had been flying together. Seventy-seven percent of the IPs indicated that formal navigation communication instructions presented in the classroom would be more desirable than IPs teaching their students individually the navigation terms and techniques that should be used.

75-14. **Report of cold climate clothing and survival equipment workshop.** April 1975. *(ADA032837)*
USA-AAVS 75-2

By Russell D. Nelson, Emil Spezia, William R. Brown, William B. Durand, and Huey P. Lang.

Report of Cold Climate Clothing and Survival Equipment Workshop held 24-27 September 1974 at Fort Rucker, Alabama.

Recognition of needs for improvement in aviation cold climate equipment prompted the U.S. Army Agency for Aviation Safety and the U.S. Army Aeromedical Research Laboratory to jointly sponsor a workshop to identify shortcomings in the Army's cold climate clothing and survival equipment and recommend solutions. The workshop focused on specific problems encountered by Army aviation in Alaska. However, requirements of aviation units operating in other cold climates also were addressed.

The workshop resulted in identification of deficiencies in cold climate flight clothing, cold climate survival kits, individual vest-type survival kits, cold climate training, emergency locator transmitters, and management of life support equipment.

Attendees were representatives of concerned agencies and commands. They recommended actions to expedite short-term improvement of U.S. Army Alaska's cold climate equipment and to effect a long-term overall improvement in Army aviation's cold climate life support and survival equipment and management.

Also included is a report on the workshop to draft requirements for a Cold Weather Flight Clothing System held at Fort Rucker, 9-13 December 1974.

75-15. **A cross-validation study of the personality aspects of involvement in pilot-**
USA- **error accidents.** March 1975. *(ADA010352)*
AAVS
75-3 By Michael G. Sanders, Mark A. Hofmann, and Thomas A. Neese.

Pilot-error accidents have dominated accident statistics consistently from the 1940s to the present. Sanders and Hofmann (1975) found that three factors from Cattell's Sixteen Personality Factor Questionnaire (16 PF) showed significant differences ($p < .05$) between pilot-error accident groups and were used to correctly classify 86 percent of the aviators tested as to their previous pilot-error accident involvement. Sixty-six aviators were given the 16 PF in the present study in an attempt to cross-validate the findings reported in the original study. The results indicate that the personality factors did not significantly discriminate between the pilot-error accident groups. The primary personality differences between the present sample and the original sample were due to variations in the pilot-error accident free groups. The findings indicate that individual differences in personality characteristics of the aviators prevent consistent identification of traits associated with pilot-error groups.

75-16. **(This report number was not used.)**

75-17. **In-flight evaluation of hand-held stabilized optical viewing devices.** April 1975. *(ADB003761L)*

By David D. Glick and Roger W. Wiley.

Five hand-held stabilized optical viewing devices were compared in-flight. Three were prototype models and two were commercially available. Considering size, weight, complexity, and performance in a target identification task, one of the prototypes looks very promising.

75-18. **Word intelligibility of two types of synthesized voice warning systems.** April 1975. *(ADB015274L)*

By Alan L. Croshaw, James H. Patterson, Jr., Robert T. Camp, Jr., and Ben T. Mozo.

At the request of the U.S. Army Aviation Systems Command, the U.S. Army Aeromedical Research Laboratory conducted speech intelligibility tests on two types

of synthesized voice warning systems produced by Northrop Corporation and McDonnell Douglas Corporation. The purpose of the tests was to determine the intelligibility of the synthesized speech samples when presented at normal conversational levels and to compare the relative intelligibility of the two productions with each other. Mean intelligibility scores ranged roughly from 40 to 65 percent. The scores obtained with the McDonnell Douglas simulated male and female voices and the Northrop simulated male voice were not significantly different. However, recordings of the Northrop simulated female voice yielded significantly lower scores than the samples of the other three simulated voices. Familiarization of the subjects with test words and synthesized voice significantly improved intelligibility over those not given the familiarization training. None of the samples evaluated yielded intelligibility scores which could be considered functionally adequate.

75-19. **Enhancement of visual performance in Army aviation: A comparison of two commercial products for repairing acrylic aircraft transparencies.** May 1975. *(ADB004659L)*

By Frank F. Holly.

Abrasions on the transparent enclosures of Army aircraft can seriously impair visual performance. Therefore, this study was undertaken to determine the relative merits of two products, Polysand™ and CL™ polish, for removing abrasions from these enclosures. The results of this study showed that for abrasions of a magnitude at least as great as moderate-to-heavy windshield wiper abrasions (one of the most common types of abrasive failure) CL™ polish represents a faster and easier means of removing the abrasions. For deep scratches, however, a product such as Polysand™ or Micromesh™ must be used.

75-20. **Effect of oxygen and reduced glutathione on the oxygen consumption of mouse liver.** May 1975. *(ADA012172)*

By Dennis A. Baeyens and Mary J. Meier.

The effects of hyperbaric oxygen tensions on the oxygen consumption of mouse liver homogenates were investigated. Hyperbaric oxygen rapidly inhibits the oxidative metabolism of the mammalian liver. Mouse liver homogenate exposed to a PO_2 of 3837.8 mm Hg for 30 minutes showed a 50.6 percent reduction in oxygen consumption compared to controls exposed to nitrogen at ambient pressure. The effect of reduced glutathione (GSH) as a protective agent against hyperbaric oxygen toxicity also was examined. Liver homogenates pretreated with GSH and exposed to high oxygen tensions demonstrated greater activity than untreated controls. It is concluded that: (1) GSH protects important enzymes of oxidative metabolism by keeping them in a reduced and viable state, and (2) GSH can stimulate oxygen consumption by increasing succinate formation through a GSH-succinate shunt.

75-21. **Orientation-error accidents in regular Army UH-1 aircraft during Fiscal**
NAMRL **Year 1971: Relative incidence and cost.** June 1975. *(ADA014423)*
1218

By W. Carroll Hixson and Emil Spezia.

This report is the fifth in a longitudinal series of reports dealing with the magnitude of the pilot disorientation/vertigo accident problem in regular Army UH-1 helicopter operations. Incidence and cost data presented for Fiscal Year 1971 include a total of 31 major and minor orientation-error accidents (15 of which were fatal), resulting in 44 fatalities, 52 nonfatal injuries, and a total UH-1 aircraft damage cost of $6,337,446.

75-22. **The use of opaque louvers and shields to reduce reflection within the cockpit: A mathematical treatment.** June 1975. *(ADA012655)*

By Wun C. Chiou and Frank F. Holly.

Opaque shields can be used to channel light and thereby reduce reflections in the cockpit. These shielding devices range from the standard glare shield on top of the instrument panel to the more experimental use of Light Control Film[R] and Micromesh[R] for this purpose. Because of the need to determine the best position, width, spacing, etc., of these shielding devices, it was felt that a systematic approach would be highly desirable. This work shows a mathematical approach to this problem and includes derivations, examples, and a suggested figure of merit.

Fiscal Year 1976

76- 1. **Major orientation-error accidents in regular Army UH-1 aircraft during Fiscal Year 1971: Accident factors.** July 1975. *(AD749965)*
NAMRL
1219

By W. Carroll Hixson and Emil Spezia.

This report is the fifth in a longitudinal series of reports dealing with the pilot disorientation/vertigo problem in regular Army UH-1 helicopter operations. Individual case history data extracted acted from the USAAAVS master aircraft accident files are presented on major UH-1 orientation-error accidents that occurred during Fiscal Year 1971. Summary data listings involving a variety of operational and pilot-related accident factors are presented for each of the 31 cases. The listings are arranged to distinguish between those factors and events present before takeoff, i.e., the initial conditions associated with a given accident, and those which occurred or were manifested during the actual airborne phase of the accident flight.

76- 2. **Buettner cueing concept for helicopter flight control.** August 1975. *(ADA016885)*

By Robert H. Wright.

Familiarization was obtained with a helicopter flight control cueing concept developed by a retiring senior flight instructor, with emphasis on its potential application to night vision imaging systems. It consisted of a simple set of windshield marks arranged to provide precision in contact control of pitch attitudes. Students trained with it seemed to find advanced contact and instrument training much easier than traditionally-trained students, and experienced helicopter pilots introduced to the concept felt it provided substantial improvement in their control precision. Conclusions from this exploratory familiarization were the Buettner-type cue sets (a) have potential for reducing perceptual ambiguities in helicopter control with night vision devices; (b) increase precision and lead in helicopter contact control, (c) should provide a high level of transfer to instrument training, (d) with slight extension have potential as an approach aid, particularly for an underslung night vision device, and (e) appear to have potential for very simple helicopter simulator visual displays that should have considerable value for initial or transition training.

76- 3. **Perceived velocity and altitude judgements during rotary-wing aircraft flight.** September 1975. *(ADA016870)*

By Richard N. Armstrong, Mark A. Hofmann, Michael G. Sanders, Lewis W. Stone, and Charles A. Bowen.

Eight Army rotary-wing aviators made judgements concerning the ground speed and altitude of a UH-1 helicopter. Combinations of three ground speeds and four altitudes were used across four visual conditions including daylight and simulated night environments. In general, the results indicate: (1) Absolute error in ground speed estimations increased as altitude increased; (2) at ground speeds above 50 knots there was a tendency to underestimate ground speeds, and below 50 knots ground speed estimates were dependent upon visual conditions; (3) absolute error in altitude judgement increases with aircraft altitude; (4) at low altitudes, the trend is toward underestimation and as altitude and airspeed increase, the tendency is to overestimate altitude. These and other results are discussed as well as their possible implications for conduct of safe flight.

76- 4. **The use of opaque louvers and shields to reduce reflection within the cockpit: A trigonometrical and plane geometrical approach.** September 1975. *(ADA017366)*

By Chun K. Park and Franklin F. Holly.

Opaque shields can be used to channel light and thereby reduce reflections

within the cockpit. These shielding devices range from the standard glare shield on top of the instrument panel to the more experimental use of Light Control Film® and Micromesh® for this purpose. Because of the need to determine the best position, width, spacing, etc., of these shielding devices, it was felt that a systematic approach would be highly desirable. This work describes a mathematical analysis to assess the applicability of those devices to resolve aircraft windscreen reflection problems.

76- 5. **Object visibility patterns in low level flight.** September 1975. *(ADA016886)*

By Robert H. Wright and J. Nicholas DeBonis.

Line-of-sight viewing angle, range and time distributions are given for a 70 kilometer sample of tree-top level annular (fisheye) imagery, and comparisons made between these data and theoretical random single tree line of sight distributions. The effects of location over open and tree covered terrain are assessed and limited data on the effect of altitude presented. Relative azimuth, elevation, and range of objects when they first emerged into view were recorded by type of object. Relative angle of crossing linear features was determined, along with the duration that information of navigational value could be determined.

When over trees the actual masking function was grossly different from the theoretical curves, while over open terrain actual masking approximated the five percent cover theoretical curve at close range and the one percent curve at 1000 meters. Over trees, masking for tank-sized vehicles ranged from 83 to 93 percent, and over open terrain from 10 to 77 percent. Only 12.5 percent of linear features were found to be oriented within plus or minus 30 degrees of the nose at crossing, while 58.3 percent were within plus or minus 30 degrees of perpendicular to the nose. This finding implies viewing to the sides as an aircraft crosses features is necessary in order to see the feature details that will provide positive geographic orientation. The detailed viewing along linear features required for positive geographic orientation was available for an average of 24 meters, or 1 second at 50 knots. Limited data are presented on the effect of altitude on duration of line of sight to objects that provide information of value in geographic orientation.

76- 6. **The use of opaque louvers and shields to reduce reflections within the cockpit: Computer programs for two approaches to the problem.** November 1975. *(ADA018468)*

By Wun C. Chiou, Frank F. Holly, Chun K. Park, and Alfred A. Higdon, Jr.

Opaque shields can be used to channel light and thereby reduce reflections within the cockpit. These shielding devices range from the standard glare shield on top

of the instrument panel to the more experimental use of Light Control Film® and Microsmesh® for this purpose. Previous work in this series has demonstrated two mathematical approaches to a specific reflection problem in the AH-1 aircraft, namely, the reflections coming from the portion of canopy directly above the gunner's head. It was felt that it would be useful to demonstrate the compatibility of these two approaches and to publish the computer programs (FORTRAN) for each approach for possible use by others.

76- 7. **Bio-optical evaluation of specialized eyewear: Laser safety and dark adaptation devices.** November 1975. *(ADA019787)*

By Wun C. Chiou and David D. Glick.

This report provides quantitative data and color vision evaluations for several types of goggles. The first two types are laser safety devices and the other three are for dark adaptation purposes. It is found that He-Ne laser safety eyewear conforms to the Army regulation specification. It is recommended that one type of the safety device cannot be used for only one specific purpose. Furthermore, the laser safety device cannot be used when a detection of a red display or a red light source is required. Results from the dark adaptation devices show that the spectral transmission characteristics possess virtually a common distribution.

76- 8. **Photometric and colorimetric characteristics of chemiluminescence-Cyallune®.** November 1975. *(ADA019788)*

By Wun C. Chiou and Danny N. Price.

This report presents an analysis of the photometric as well as the colorimetric characteristics of chemiluminescence-Cyalume®. It has been demonstrated that the chemical light offers advantages over other light sources because it generates light without thermal energy. It is suitable for situations where the use of conventional light could be hazardous. It works in all weather conditions and under water as well.

On the other hand, its disadvantages include the relatively short lifetime of useful light, the poor color discrimination because of the narrow band spectral emission and a slight chromatic variation as a function of time. Nonetheless, it has potential military applications such as emergency lighting in aircraft, a guide for hoist missions, a set of heliport markers, a ground guide, or a parachute locator.

76- 9. **Real-ear attenuation of selected communication headsets available through the Federal supply system.** December 1975. *(ADB013117L)*

By Alan L. Croshaw, James H. Patterson, Jr., Ben T. Mozo, and Robert T. Camp, Jr.

Eight different headsets submitted by Defense Electronics Supply Center (DESC) and an H-132/AIC headset were compared for the amount of real-ear sound attenuation they provide. The H-132/AIC, a "state-of-the-art" device, was superior to all of the other eight devices tested. Among the headsets submitted by DESC the H-140(B)/U, H-157/AIC, David Clark Prototype and USAMC P/N 10673294-1 provide the most attenuation, and the H-158/AIC, H-161(C)/GR, H-173(B)/AIC and H-251/U provide the least.

76-10. **Aviator performance measurement during low altitude rotary-wing flight with AN/PVS-5 night vision goggles.** December 1975. *(ADA020631)*

By Michael G. Sanders, Kent A. Kimball, Thomas L. Frezell, and Mark A. Hofmann.

Aviators were required to fly a UH-1 helicopter at night with and without night vision goggles (AN/PVS-5). Three types of goggles were used: 40 degree field-of-view (FOV), 60 degree FOV, and 40 degree FOV with a 30 percent bifocal cut. During flight, data was acquired on over 20 aircraft status and control input variables. These data, for purposes of performance comparison, were subjected to both univariate and multivariate analyses. The six subjects (instructor pilots) also responded to a questionnaire regarding preference, training and estimated capabilities of each type intensification system. The major finding of both the subjective and objective measures are provided.

76-11. **Some specific effects on hypobaric hypoxia on cellular metabolism.** January 1976. *(ADA028928)*

By Dennis A. Baeyens and Mary J. Meier.

The lactate dehydrogenase (LDH) and succinate dehydrogenase (SDH) activity of mouse liver homogenates were examined after exposure to an equivalent altitude of 36,000 feet and compared to controls kept at ground level. After 6- and 12-hour incubation periods, the altitude exposed samples demonstrated a significantly higher LDH activity than controls. SDH activity remained unchanged from controls after 6 hours but was significantly lower than controls after 12-hour exposures to altitude. It is concluded that the changes in enzyme activity reflect a metabolic control mechanism to maintain adequate energy production during periods of exposure to hypobaric hypoxic stress.

76-12. **The effect of behavioral paradigm on auditory discrimination learning: A literature review.** February 1976. *(ADB015275L)*

By Charles K. Burdick.

The ability of animals to discriminate sounds has been investigated using either go/no-go or two-choice paradigms. A review of the literature shows that for easy distinctions such as tone vs. noise, go/no-go procedures are generally learned within 200-400 trials while two-choice procedures have taken considerably longer to be learned. The minimum amount of training with two-choice procedures has generally been 1200-1400 trials and thousands of trials often have been necessary. The effect is found across species and in both positive and negative reinforcement situations. Until further investigations are conducted, the question remains as to whether the difficulty in training is due to methodological shortcomings or to biological limitations on the ability of animals to associate sounds and responses. The review illustrates that there is a dearth of information concerning the parameters of auditory discrimination learning. It is recommended that investigators interested in the auditory capabilities of animals use go/no-go procedures.

76-13. **Computer modeling of the body-head-helmet system: Volume I.** February 1976. *(ADA023785)*

By Wartan A. Jemian and Nan-Heng Lin.

Three dimensional finite element methods of analysis were applied to the body-head-helmet structural system under conditions of static equilibrium and to the head-helmet assembly in a dynamic mode. Computer programs were written to generate the three dimensional grids, to evaluate inertial properties, and to process and display results of the structural analyses. Structural analyses were performed using Structural Analysis Program IV supplied by the University of California. Static analysis, using a fixed configuration, is applicable to the description of displacement and stress component fields in the system. The results of this mode of analysis have the potential of yielding information related to loss of consciousness due to impact situations. Dynamic structural analysis was performed on a computer-generated pseudospherical model simulating the drop test.

Results provide time traces of the displacement, velocity, acceleration, and stress components at selected nodal points and elements of the system. Methods were demonstrated for the determination of a number of parameters of potential or proven value in evaluating crash protection or crash severity. These include linear acceleration profile, rotational acceleration profile, shear stress, skull deflection, severity index, mass moments of inertia, and regional centers of gravity. Six specific recommendations were made for steps to be taken in applying finite element simulation to helmet design. These include the development of a head form simulation

in the dynamic mode and the addition of elements to represent nonlinear and anisotropic materials behavior to portions of the system as appropriate.

76-13. **Computer modeling of the body-head-helmet system, Volume II: Finite element coordinates and computer subroutines for a body-head-helmet system.** February 1976. *(ADA023786)*

By Wartan A. Jemian and Nan-Heng Lin.

This report is a supplement to the basic report entitled "Computer modeling of the body-head-helmet system." As such, it should be used with the basic report for maximum clarity. Nodal point coordinates and boundary conditions for a fixed-body-head-helmet configuration as listed. A 3X3X3 pseudosphere head-helmet configuration also is listed. A listing of service in FORTRAN calls on the facilities and subprograms of the IBM operating system and the Calcomp Plotter. The services listed should perform all of the operations referred to in the basic report.

76-14. **Visible and near infrared spectral transmission characteristics of windscreens in Army aircraft.** February 1976. *(ADA022769)*

By Wun C. Chiou.

This report presents an analysis of the spectral transmission characteristics from 360 to 1080 nm spectral range of 16 Army aircraft windscreen samples. Those samples were from six fixed-wing and seven rotary-wing aircraft windscreens. We have found that the spectral transmittance varies from sample to sample in the visible portion of the spectrum (i.e., 360-700 nm) and remains quite flat for all the samples across the near infrared portion of the spectrum (i.e., 700-1080 nm). The tinted sample in AH-1 Huey Cobra has about 27 percent reduction from that of the clear one across the visible spectrum. This reduction could constitute a dangerous loss of visibility for the aviator during periods of reduced illumination and at night. Furthermore, the variance from a flat spectral transmission would result in distorted color perception by the aviator viewing through the tinted windscreen. In short, the reference data enable potential users of electro-optical devices such as night vision goggles to compute the light stimulus presented to the aviator after transmission through a transparency.

76-15. **Development of a prototype experimental plan to evaluate stabilized opti-**
NAMRL **cal viewing devices: II. In-flight measures of airsickness potential.**
1223 March 1976. *(ADA025455)*

By W. Carroll Hixson, Fred E. Guedry, Jr., Joel W. Norman, David D. Glick, and Roger W. Wiley.

Investigators at the Naval Aerospace Medical Research Laboratory and the U.S. Army Aeromedical Research Laboratory conducted a combined field and laboratory study to evaluate observer performance while using an improved XM-76 stabilized viewing device. Air-to-ground observations were made in a UH-1 aircraft, flying maneuvers modeled in part after a scout helicopter scenario. The experimental protocol was such that visual acuity data was collected under three different observation conditions: With the naked eye, with XM-76 operated in its normal stabilized mode, and with the XM-76 operated in a caged or nonstabilized mode.

Measures of selected airsickness symptoms were derived from an on-board flight observer and from postflight questionnaires. The resulting data indicate that the level of airsickness symptoms manifested by the subject group while using the device was higher than the base line level present when the observations were made without the device. This rise in symptom level was found to be present whether the XM-76 optics were stabilized or nonstabilized. Importantly, no statistically significant difference could be found between the magnitude of the symptoms present when the device was stabilized and the magnitude when caged. In contradiction to the hypothesis that the stabilization feature of such devices increases the airsickness potential, the general trend of the data showed the opposite effect.

A previous report detailed the results of the visual acuity aspects of the project. The present report pertains primarily to the in-flight measures of airsickness potential. A third report will describe the results of the laboratory evaluation of airsickness susceptibility of the individual subjects.

76-16. **Preliminary medical assessment of the acoustic hazard of a prototype mechanized infantry combat vehicle.** March 1976. *(ADB015276L)*

By James H. Patterson, Jr., Ben T. Mozo, and Robert T. Camp, Jr.

This report contains a preliminary medical assessment of the noise hazard inside the Mechanized Infantry Combat Vehicle (MICV). Sound pressure levels were measured at four positions inside a prototype MICV. Analysis of the data from measurements at three speeds on two road surfaces indicates the levels inside the MICV greatly exceed the limits of TB MED 251 and MIL-STD-1474A (MI).

Further analysis indicates that even when commonly available hearing protectors are used, the effective sound pressure levels at the ears of the crewmen are greater

than 85 dBA. It is recommended that the noise inside this vehicle be reduced before further development.

76-17. **Marijuana and human performance: An annotated bibliography (1970-1975).** March 1976. *(ADA024781)*

By Melody L. Pagel and Michael G. Sanders.

The effects of marijuana upon human performance is currently an area of major concern. No place is this concern more acute than in complex man-machine systems, such as those found in aviation, where degradations in psychomotor and/or cognitive performance can result in catastrophic losses. This annotated bibliography consisting of 199 references was compiled to aid the reader in determining the impact of this drug on psychomotor, cognitive, and physiological factors considered pertinent to flight performance. The bibliography contains an index which categorizes the references into the following areas: (1) Reviews or overviews of issues, literature, or research; (2) psychological effects of marijuana use; (3) physiological and pharmacological research; (4) medical comments and research critiques; and (5) additional reference sources. The basic period of coverage is 1970-1975, although selected studies from earlier years also are included.

76-18. **Pilot opinion of flight displays and monitoring gauges in the UH-1 helicopter.** April 1976. *(ADA024714)*

By Ronald R. Simmons, Mark A. Hofmann, and Michael A. Lees.

Subjective responses were acquired from 54 Army aviators concerning the UH-1 instrument panel. The aviator subjects were drawn from three experience levels: Student, "tac-ticket," and fully instrument rated pilots. They were asked to rank instruments with regard to frequency of use, order of preference, reliability, and readability. The instruments were divided into flight displays and monitoring gauges. Ranks were requested for various profiles and flight conditions. Data analyses examined the mount of agreement between experience levels as well as the rankings concerning the areas mentioned above.

It was determined that all experience levels were in high agreement with regard to their opinions concerning the frequency with which they used the various monitoring gauges and flight displays while hovering, climbing, cruising, and descending in both IFR and VFR conditions. The flight displays thought to be most often used were the airspeed indicator followed by the altimeter. For the monitoring gages, engine rpm and the gas producer were ranked one and two respectively for frequency of use.

76-19. **Aeromedical review of oxygen requirements of U.S. Army aviators.** April 1976. *(ADA024726)*

By Frank S. Pettyjohn and Roderick J. McNeil.

Aeromedical review of U.S. Army aircraft oxygen design criteria and military specification indicates physiologic inconsistencies. Oxygen duration charts in use for U-21 aircraft are computed on the basis of military specifications using inspiratory minute volume (IMV) of 13.12 liters per minute (LPM), normal temperature (70 degrees F), pressure, dry (NTPD). Current oxygen duration charts for the RU-21 aircraft using constant flow regulator have overstated oxygen availability of 62.3 percent at 10,000 feet and 18.7 percent at 15,000 feet. Type regulator and dilution schedule are listed for U-21 series aircraft. The current design inspiratory minute volume of 13.12 LPM NTPD is the basic design deficiency. The effects of the activity and stress of flight require an increase of design IMV.

76-20. **Lens material evaluation (goggles, sun, wind, and dust).** May 1976. *(ADA025778)*

By Isaac Behar and Roger W. Wiley.

Optical evaluations of lenses considered as candidates to replace the visor in the combat vehicle crewman's protective goggles are described. The four areas of optical evaluation were: Spectral transmission, haze, optical distortion, and abrasion resistance. All of the lenses were found to have adequate properties of transmissivity and freedom from haze. However, none of the lenses submitted for evaluation were medically acceptable because of excessive optical distortion. The optical coatings under consideration to increase scratch resistance of the polycarbonate lenses provided only negligible improvement. If polycarbonate is determined to be the material of choice, a higher optical quality should be used and a better method of providing abrasion resistance should be sought.

76-21. **Reduction of glare from the landing lights of the OH-58: An evaluation of four potential solutions.** May 1976. *(ADA025779)*

By Frank F. Holly.

Four potential solutions to the OH-58 landing lights glare problem were evaluated. The four solutions consisted of: (1) Placing a metal shield beneath each landing light; (2) placing shields on each side of the cockpit extending laterally and forward from the instrument panel; (3) taping over the inside one-half of each chin-bubble; and (4) taping over the sides of the plexiglass sheet light well. The first three solutions were all found to be very effective, but the preferred solution was the placing of shields beneath the landing lights (solution 1) since this involved no visi-

bility loss or extra material inside the cockpit. However, the overheating of the plexiglass sheet over the light well caused by these metal shields will have to be overcome before this solution is acceptable. It also was found that the tape over the inside one-half of each chinbubble is a very good field-expedient "quick fix."

76-22. **Head injury pathology and its clinical, safety, and administrative significance.** April 1976. *(ADA073532)*

By Stanley C. Knapp and Thomas M. Erhardt.

The occurrence of head trauma is so common that its true importance as a major statistic associated with accidental injury and death may be overlooked. A review of head trauma in war, vehicular accidents, sports, and aviation demonstrates that while the head constitutes roughly 9 percent of the body's weight, surface area, and volume, it is implicated in 7 out of 10 body injuries. Generally speaking, head trauma causes an unacceptable 1 in 4 deaths and for motorcycling it causes a staggering 1 out of every 2 deaths. Head protective devices have been available since antiquity; but except in isolated circumstances they can not be shown to have had a mitigating effect on the magnitude of the injury rate. Yet, the technology exists to prevent head-injury deaths and to greatly reduce injury severity in survivable accidents, especially in aviation.

While it is accepted that helmets, indeed, provide significant protection, most systems of accident investigation, injury analysis, and data recording do not recognize head trauma as endemic or even epidemic. Thus, the problem has not been approached epidemiologically. Instead, the bulk of head injury research is directed toward improved treatment and prevention of disability. These efforts are on the secondary and tertiary levels of prevention. Head trauma is expensive, as is the technology to avert it; but the authors contend that available statistical data cannot support the cost effectiveness of preventing head injury. In the future, examination of head trauma, its cost and the effectiveness of provided protection must apply the analytical tools of epidemiology not only to the injury but to the equipment as well. Prevention requires anticipatory action, based on the knowledge of protective performance history, in order to make the onset or further occurrence of injury unlikely.

76-23. **Attenuation of light transmission in Army aircraft transparencies due to slanting.** June 1976. *(ADA027664)*

By Wun C. Chiou, Chun K. Park, and Chris E. Moser.

The rates of light transmission reduction due to the slanting in eight fixed-wing and 14 rotary-wing aircraft transparencies have been examined. We found that the optical quality at various portions of the UH-1 transparencies and all the fixed-wing samples possess similar characteristics of transmission reduction. The windscreen

and the armor glass of CH-54 samples are similar too. But the tinted versus the clear AH-1G transparencies are quite different. The tinted sample generally has 27 percent spectral transmission loss compared to that of the clear sample. This reduction could constitute a dangerous loss of visibility for the aviator, especially during periods of reduced illumination and at night. The results presented in this study enable the potential users of optical as well as the electro-optical devices to compute the amount of transmission reduction in most of the current Army aircraft.

76-24. **Dynamic visual acuity in fatigued pilots.** June 1976 *(AD027663)*

By Isaac Behar, Kent A. Kimball, and D. A. Anderson.

Six rotary-wing aviators were subjects in a continuous operation regimen involving some 12 hours of flying and 3.5 hours of sleep daily for 5 days. Estimates of performance on a dynamic visual acuity (DVA) task were obtained several times each day during the study using target velocities of 25 degrees and 40 degrees/sec. DVA performance varied significantly during fatigue regimen when measurements were made with target velocities of 40 degrees/sec; with lower velocity targets differences in DVA scores were not significant. This indicates the need to tax the oculomotor system to demonstrate fatigue effects. Fatigue effects were partially obscured by practice efforts which are considerable in the DVA task. DVA scores correlated only modestly with subjective estimates of fatigue intensity and flying performance, and IP ratings of performance, but the cluster of correlations provided a consistent picture.

76-25. **Depth perception with the AN/PVS-5 night vision goggles.** July 1976. *(ADA029542)*

By Roger W. Wiley, David D. Glick, Carol T. Bucha, and Chun K. Park.

Laboratory measures of stereopsis and field measures of relative depth discrimination while using the AN/PVS-5 night vision goggles were determined and compared with data of unaided eye performance. Using a modified Howard-Dolman apparatus, the stereoscopic threshold was found to be considerably degraded with the man-goggles system when compared to photopic unaided eye performance. Field measurements of relative depth discrimination using all available visual cues showed that performance of the man-goggles system was statistically equivalent only at intermediate distances of 500 feet or less. However, performance was inferior to unaided viewing at distances greater than 500 feet. These results are attributed primarily to the loss in resolution with the man-goggles system and thus a failure to appreciate subtle visual cues normally available for depth discrimination.

76-26. **Versatile manova: Design and documentation.** August 1976. *(ADA030052)*

By Thomas R. Schori.

Recognizing the complexity inherent in human performance, investigators typically utilize multiple dependent variables in human factors or ergonomics research. It is apparent from the literature, though, that they often employ a series of univariate analyses to analyze their data, when a single multivariate analysis would be appropriate. In many cases, the investigator may be aware that a multivariate analysis should be employed.

However, the appropriate multivariate analysis may never have been described or it may produce results which the investigator is unable to interpret. Therefore, the investigator must resort to a series of univariate analyses. To rectify this situation, the writer prepared the computer program Versatile MANOVA, a copy of which is included in the Appendix. This program can handle five multivariate analyses of variance (MANOVA) designs that are frequently encountered in human factors and ergonomics research: (1) One-way MANOVA, independent groups design; (2) one-way MANOVA, repeated measures on subjects design; (3) two-way MANOVA, independent groups design; (4) two-way MANOVA, subjects repeated on one factor design; and (5) two-way MANOVA, subjects repeated on both factors.

Each design incorporates the "interpretation enhancement" feature that is normally only associated with multiple discriminate analysis. In order to provide the potential user with some basic understanding of the analyses, this paper fully describes and documents the five MANOVA designs in Versatile MANOVA.

76-27. **In-flight performance with night vision goggles during reduced illumination.** August 1976. *(ADA031991)*

By Michael A. Lees, David D. Glick, Kent A. Kimball, and Allen C. Snow, Jr.

At the present time, the U.S. Army is striving to attain around-the-clock operational capability for its tactical forces. The night vision goggles have been developed to aid the Army pilot in attaining near-daytime capability at night. Previous research at the U.S. Army Aeromedical Research Laboratory has demonstrated the requirement for an investigation of the effects of low illumination levels on aviator performance while wearing night vision goggles.

The current investigation examined man-helicopter system performance across several levels of reduced illumination. Neutral density filters were used to present six standard illumination conditions to aviators wearing night vision goggles, and to simulate unaided eye conditions to aviators wearing welders' goggles. Significant differences in system performance were observed when aviators wore the night vision

goggles. The results of the multivariate analysis of variance and recommendations based on observed performance are presented in this report.

Fiscal Year 1977

77- 1. **Mass spectroscopic analysis of polyether and polyurethane foam plastics degeneration in the SPH-4 helmet.** October 1976. *(ADA036447)*

By Roderick J. McNeil and Frank S. Pettyjohn.

Two components of plastic manufacture, n-butylphthalate and ethylmethyl ketone, have been found in high concentrations contained in the low gaseous transfer coefficient polyethylene protective bag for the SPH-4 aviator helmet. These agents are the cause of the deterioration of the SPH-4 helmet polyether and polyurethane foam lining material.

The use of mass spectrographic and gas chromatographic techniques provided the sampling of chemical compounds contained within the polyethylene bag. The solution to prevent foam liner deterioration is to remove the SPH-4 helmet from the protective bag.

77- 2. **Effects of oxygen and glutathione on the oxygen consumption and succinate dehydrogenase activity of the liver.** October 1976. *(ADA036448)*

By Dennis A. Baeyens and Mary J. Meier.

The effects of hyperbaric oxygen tensions on the oxygen consumption and succinate dehydrogenase (SDH) activity of mouse liver were investigated. Mouse liver homogenate exposed to a PO_2 of 3837.8 mm Hg for 30 minutes showed a 50.6 percent reduction in oxygen consumption compared to controls exposed to nitrogen at ambient pressure. The SDH activity of mouse liver was reduced significantly after a 3-hour exposure to a PO_2 of 3796 mm Hg.

The effect of glutathione as a protective agent against oxygen toxicity also was examined. Liver pretreated with reduced glutathione and exposed to high oxygen tensions demonstrated greater activity than untreated controls. Oxidized glutathione protected SDH against hyperbaric oxygen toxicity.

It is concluded that glutathione can stimulate oxygen consumption and maintain SDH activity after exposure to hyperbaric oxygen by increasing succinate formation through the glutathione-succinate shunt.

77- 3. **Aviator performance during day and night terrain flight.** December 1976. *(ADA034898)*

By Michael A. Lees, Kent A. Kimball, Mark A. Hofmann, and Lewis W. Stone.

Terrain flying, both day and night, now is an Army aviation tactical requirement. The present investigation compared terrain flight during low level (LL) and nap-of-the-earth (NOE) profiles for: (1) Day flight with the unaided eye; (2) night flight with the unaided eye; (3) night flight using night vision goggles.

Data were acquired through the use of the Helicopter-In-flight Monitoring System (HIMS). The total sets of in-flight measures were analyzed separately for both LL and NOE with further analysis on the subsets of pilot control variables and aircraft status variables.

Multiple discriminate analysis techniques were used to determine which measures best discriminated between visual conditions. For the LL flight profiles, the results indicate that performance factors describing air speed and the frequency of small control inputs best discriminated between visual conditions. For NOE flight profiles, it was determined that performance factors measuring severity of roll angles, and the frequency and magnitude of control input, best discriminated between the three visual conditions.

77- 4. **Measurement of aviator visual performance and workload during helicopter operations.** December 1976. *(ADA035757)*

By Ronald R. Simmons, Kent A. Kimball, and Jamie J. Diaz.

This report was initiated to review the techniques and modifications developed by the U.S. Army Aeromedical Research Laboratory for assessing visual performance/workload of pilots during helicopter operations. Although the corneal reflection technique for gathering eye movement data is not new, innovative modifications had to be developed to permit accurate data collection in this flight environment. This study reports on these techniques, modifications, and applications.

77- 5. **The in vivo dynamic material properties of the canine spinal cord.** December 1976. *(ADA223294)*

By Y. King Liu, K. B. Chandran, and J. K. Wickstrom.

A wave propagation study was completed to determine the in vivo dynamic material properties of the dura mater in mongrel dogs. A portion of the thoracic spinal cord was exposed by laminectomy. The dog was artificially respired after its

muscles were paralyzed to prevent any jerk reflex initiated by the spinal cord during the experiment. In the pressure wave experiments, sinusoidal pressure signals were induced on the in vivo and in situ spinal cord with a probe attached to an electromagnetic vibrator. At two other locations, signals were monitored by pressure transducers pressed gently against the cord. The speed of the wave propagation was determined at various frequencies from the measured time lag and the distance between the transducers.

Assuming a model of an elastic tube filled with inviscid fluid, the Young's modulus for the dura in the circumferential direction was computed via the so-called Moens-Korteweg equation. Similar measurements were made on the axial and torsional waves. These waves were induced by attaching a specially-designed adapter to the vibrator. The propagation of these waves was monitored at two other locations, where targets with an optical discontinuity (black and yellow interface) were mounted. The movement of these targets as a result of the wave transit, were followed by an electro-optic tracking system. The results showed that the spinal dura mater behaved like an anisotropic medium, being stiffest when loaded normal to its surface and softest under torsional loading. Based on the experimental data, mean values for the circumferential and Young's moduli and shear modulus, useful for the frequency range of these tests were recommended.

77- 6. **Preliminary evaluation of the oxygen use rates in U.S. Army aircraft. Part I---RU-21H.** November 1976. *(ADA036600)*

By Frank S. Pettyjohn and Mary J. Meier.

Accurate inspiratory minute volume (IMV) is required for U.S. Army fixed- and rotary-wing aircraft oxygen system design. This initial study evaluated oxygen usage rates of U.S. Army aircrew conducting operational missions at altitudes of 19,000 to 25,000 feet flying RU-21H twin turbo-propeller driven underpressurized aircraft. Inspiratory minute volume (IMV) was calculated from the crew dilutor demand oxygen regulator pressure gauge and timed mission profiles. The IMV results were consistent with consideration of the limited accuracy of the pressure gauge through 56 flights with 112 pilot and copilot crewmembers. The average IMV was 8.09 ± 2.14 Standard Deviation (SD), liters per minute (LPM) at normal temperature (70 degrees F), pressure (760 mm Hg) and dry (NTPD). The range of IMV was 4.47 to 13.25 LPM NTPD per crewman. The upper limit exceeds the current military design specification of 13.12 LPM NTPD indicating an inadequate safety margin for life support equipment.

77- 7. **Aeromedical evaluation of UH-1 internal advanced personnel rescue hoists Western Gear Corporation hoist models 42277R1 and 42305R1, Breeze Corporation hoist ECP-720 modification.** February 1977. *(ADA037621)*

By Frank S. Pettyjohn, Terry E. Gee, Lloyd A. Akers, George P. Rice, William F. Carroll, Pierre Allemond, Stephen M. Bailey, Raymond T. Burden, and Thomas G. Harrison.

The U.S. Army Aeromedical Research Laboratory was tasked to provide aeromedical evaluation of advanced high performance helicopter personnel rescue hoists. Physiologic effects of increased hoist speed were evaluated and proven to be minimal at speeds of 500 feet per minute. Available helicopter electrical power provides speed up to 250 feet per minute under load limitation. State-of-the-art "off the shelf" rescue hoists were sought to provide immediate relief of the current "life or death" restriction of the U.S. Army Helicopter Air Ambulance units. Safety, continuous cycle function, improved speed and increased operational capabilities were specifically evaluated. The Western Gear Corporation two-speed hoist met the design and operational requirements.

77- 8. **Medical assessment of acoustic protective devices proposed for use in a prototype mechanized infantry combat vehicle.** March 1977. *(ADB017800L)*

By William R. Nelson, James H. Patterson, Jr., Claude E. Hargett, Jr., and Robert T. Camp, Jr.

This report contains a medical assessment of a variety of proposed hearing protective devices and combinations of devices performed in an effort to identify a means of providing adequate hearing protection to personnel exposed to the high intensity noise associated with the Mechanized Infantry Combat Vehicle (MICV). Real-ear sound attenuation data for each protected condition were obtained according to ANSI Standard Z24.22-1957.

Estimated effective dBA noise exposure levels were calculated from previous noise data and allowable exposure durations estimated IAW TB MED 251. It was recommended that E-A-R earplugs be required for all personnel at all times during operation of the MICV. Additional studies are needed to assess the adequacy of the communications system in the MICV.

77- 9. **Use of inspiratory minute volumes in evaluation of rotary- and fixed-wing pilot workload.** April 1977. *(ADA039854)*

By Frank S. Pettyjohn, Roderick J. McNeil, Lloyd A. Akers, and James M. Faber.

Inspiratory minute volume (IMV) measurements by Mueller Respirometer were utilized in the evaluation of U.S. Army aircrew workload and stress in helicopter and fixed-wing aircraft. The IMV data obtained demonstrates a significant stress and/or workload level of the aviator in performance of helicopter day nap-of-the-earth (NOE), night nap-of-the-earth (NNOE), and with the use of night vision devices (NVD). IMV of 20.05 to 38.11 liters per minute NTPD were obtained during the performance of these combat operational techniques. IMV determination in-flight is considered a valuable clinical tool in the assessment of aircrew stress and/or workload.

77-10. **Aeromedical evaluation of the Army molecular sieve oxygen generator (AMSOG) systems.** March 1977. *(ADA039855)*

By Frank S. Pettyjohn, Roderick J. McNeil, Lloyd A. Akers, George P. Rice, and Charles F. Piper.

Molecular sieve technology has been considered as an alternative source of oxygen for U.S. Army operational fixed- and rotary-wing aircraft. With the constraints of weight, size, and electrical power, the Army molecular sieve oxygen generator (AMSOG) appeared to meet operational needs. Initial design was predicated on direct replacement of current oxygen equipment for the two-man crew OV-1 Mohawk surveillance aircraft. Initial bench and hypobaric chamber testing demonstrates a capability to provide 90-94 percent oxygen at sea level using engine bleed or compressed air at 40 PSIG, 20 to 22 liters per minute (LPM), normal temperature 70 degrees F, pressure 760 Torr, dry (NTPD).

Ninety-four percent (94%) oxygen is expected to support both physiologic needs and provide denitrogenation capabilities for U.S. Army aircrew. Argon is concentrated to levels of 6-8 percent and is considered to be low; however, physiologic effects have not been fully defined. In-flight studies and toxicology evaluation are continuing.

77-11. **Comparison of oculomotor performance of monocular and binocular aviator during VFR helicopter flight.** March 1977. *(ADA040025)*

By Mark A. Hofmann and Thomas L. Frezell.

This investigation provides data concerning the visual performance of six bin-

ocular Army aviators and one monocular Army aviator during 11 flight maneuvers. All maneuvers were performed in a JUH-1H helicopter and visual data was acquired by means of a corneal reflection technique. Data was recorded on video tape and 16mm film. Thirteen visual areas were used to include: Eight windscreen sectors; two side windows and chinbubbles; and an inside cockpit sector. Data presented include percentage of time spent in each sector, average dwell time per sector, and sector transition (permutation) values. In addition to the objective data, a discussion of the retaining period for the monocular aviator was provided.

The data revealed that, in general, both the monocular aviator and binocular aviators used the same visual sectors. However, the total percentage of time they spent in these sectors were often different and so were the dwell times. The most dramatic differences in visual performance appeared when aircraft movement was in the direction of the monocular aviator's visual deficiency and in terms of the time spent inside the cockpit. The monocular aviator was found to perform all maneuvers in a most acceptable manner.

77-12. **Subjective ratings of annoyance by rotary-wing aircraft noise.** May 1977. *(ADA043435)*

By James H. Patterson, Jr., Ben T. Mozo, Paul D. Schomer, and Robert T. Camp, Jr.

Subjective ratings of annoyance caused by helicopter noise relative to that caused by fixed-wing aircraft were obtained. Comparison of the subjective ratings with various physical predictors of annoyance indicated that the integrated A-weighted level (dBA) predicted as well as any of the predictors with the D2-weighted level and EPNL almost equivalent. The B-weighted level and C-weighted level did not predict as well. No correction factor for the impulsive character (blade slap) of the helicopter noise was required. No substantial penalty for helicopters compared to fixed- wing aircraft noise was required.

77-13. **Biomedical evaluation of the standard M-1 and candidate personnel armor system for ground troops (PASGT) helmets---safety evaluation for use in airborne operations.** June 1977. *(ADB019249L)*

By Pierre Allemond and John Current.

Three candidate Personnel Armor System for Ground Troops (PASGT) helmets were evaluated in comparison with the standard airborne configuration M-1 helmet for their ability to provide impact protection and helmet retention during airborne operations. The three candidate PASGT helmets initially were found to be inferior to the airborne configuration M-1 helmet in terms of impact protection afforded, and chin strap strength and retention. In order for the candidate PASGT helmets to

perform equally or superior to the standard M-1 helmet, USAARL recommended a change in the foam nape pad material, and a change in the chin strap fabric. These changes were accomplished, and after further evaluations, it was concluded that the candidate PASGT helmets were superior to the standard airborne configuration M-1 helmet in terms of impact protection provided and chin strap strength and retention. It is recommended that the modified candidate PASGT helmets be granted a safety release for use in airborne operations.

77-14. **Visual and optical analyses of XM-29 and M-24 protective masks.** June 1977. *(ADA041249)*

By Roger W. Wiley, Isaac Behar, Wun C. Chiou, Frank F. Holly, Emery R. Spring, Carol T. Bucha, Hal Chaikin, and Carole A. Sherry.

USAARL was tasked to provide medical guidance and assessment relative to visual and optical aspects in the development of the XM-29 protective mask. In fulfillment of this responsibility, complete optical and visual tests have been completed on the new mask prior to its validation. To provide baseline and comparison information, identical optical testing also was performed on the M-24 aviator's protective mask, and visual performance testing was completed with the XM-29 mask, the M-24 mask, and unobstructed vision. Of the 13 optical and visual tests used, performance of the XM-29 mask was inferior to the M-24 mask on 8 of them; equivalent performance was obtained with the two masks on 4 tests, while the XM-29 mask was better on 1 test. Several of the optical properties are unacceptable in the present design configuration of the XM-29 mask. Recommendations are made which should be considered prior to validation of a new protective mask.

77-15. **Frequency dependence of impulse noise attenuation.** June 1977. *(ADA042031)*

By James H. Patterson, Jr., Ben T. Mozo, and Robert T. Camp, Jr.

Attempts have been made to use a single auditory value of attenuation to assess the hazard to hearing from exposure to high intensity impulse noise and to establish maximum allowable impulse noise exposure levels. This procedure ignores the interaction of the attenuation characteristics of the hearing protector and the energy density spectrum of the impulse. This report demonstrated that errors as large as 17 dB can result from failing to account for this interaction.

77-16. **Auditory discrimination learning by the chinchilla: Comparison of go/no-go and two-choice procedures.** April 1977. *(ADB020822L)*

By Charles K. Burdick.

The formulation of damage-risk criteria to protect the hearing of Army personnel relies upon an adequate technological database. Animal models are used to provide much of the relevant data because of the necessity of exposing healthy ears to damaging sounds. Behavioral conditioning procedures used with animals in noise-damage research must be studied to improve our capabilities to test and extract relevant information from the subjects. Parameters of potential importance to the improvement of current conditioning chinchillas, a major subject for auditory research, on three behavioral procedures to indicate whether a tone or noise was presented.

The efficiency of learning each procedure was compared. The three procedures are: (1) Go/no-go; (2) two-choice with visual and response homogeneity; and (3) two-choice with visual and response heterogeneity. Subjects were trained on each procedure on one of three schedules of stimulus introduction: (1) Nongraduated, in which each stimulus was presented on 50 percent of the trials throughout conditioning; (2) 0-50 percent, in which one stimulus was introduced on 50 percent of the trials after the response to the other stimulus was learned; and (3) 0-17-33-50 percent, in which one stimulus was introduced on a gradually increasing proportion of trials after the response to the other stimulus was learned.

The effect of punishment in the two-choice procedures was investigated. The reinforcement in all procedures was shock avoidance. Avoidance conditioning trials were presented while water-deprived chinchillas licked a drinking tube in the center compartment of a three-compartment shuttle box for water. It was found that go/no- go procedures were learned faster than the two-choice procedures; there was no difference between the homogeneous and heterogeneous conditions; punishment did not have a beneficial effect upon learning; and the schedule of stimulus introduction substantially affected the rate of acquisition in all procedures.

77-17. **Optical characteristics of laser safety devices.** June 1977. *(ADA223296)*

By Wun C. Chiou.

Six types of laser protective eyewear were evaluated in terms of their optical properties and spectral characteristics. These six types cover the protection for almost entire visual spectrum. Type GG-9 and Type OG530 can be used to protect the He-N (nitrogen) laser (@ 335 nm), type OG-590 and RG-610 are for argon laser @ 500 nm). Type BG-18 is for ruby laser (@ 694 nm) and type KG-3 are for Nd: Glass laser (@ 1060 nm) or CO_2 laser (@ 10600 nm). The optical properties and spectral characteristics are investigated by means of average and full spectral trans-

mittance as well as their corresponding CIE chromaticity coordinate values. Results suggested that one type of the protective device should be used only for the specific laser. Furthermore, the device should not be used when a detection of a chromatic display or light source is required.

77-18. **Toxicologic gas evaluation of the utility tactical transport aircraft system (UH-60).** July 1977. *(ADA047801)*

By Richard L. Schumaker and Gary D. Pollard.

Accumulation of toxic gases in the aircraft environment can produce a critical operational hazard for the aircrew. In addition to obvious symptoms, such as burning and irritation of mucous membranes and difficulty in breathing, other more subtle effects are noted as a general decrement in performance. This study evaluates toxic gas accumulation as a result of aircraft engine operation and toxic products generated by armament/weapons firing in the Utility Tactical Transport Aircraft System (Sikorsky UH-60) helicopter. On-board mass spectrographic analysis was utilized to identify toxic compounds during a detailed series of aircraft operational maneuvers. Carbon monoxide (CO), nitrogen dioxide (NO_2), nitric oxide (NO), sulfur dioxide (SO_2), and hydrogen cyanide (HCN) were within acceptable limits. Hydrogen sulfide (H_2S) was found on random samples to exceed the Occupational Safety and Health Administration (OSHA) standards. Techniques to evaluate H_2S on-line are being developed continuously to quantify this toxic product.

77-19. **Incidence and cost of orientation-error accidents in regular Army aircraft**
NAMRL **over a 5-year study period.** September 1977. *(ADA061705)*
1238

By W. Carroll Hixson and Emil Spezia.

This report is a summary account of the results of a joint Army/Navy study of orientation-error accidents that occurred in regular Army aviation over a 5-year period. Statistical data are presented that indicate spatial disorientation in helicopters is a significant flight hazard very comparable in magnitude to the threat generally accepted as being present with military operation of fixed-wing aircraft. Of the total number of accidents that occurred in rotary-wing (RW) aircraft over the study period, orientation error accounted for approximately 7.4 percent of the total, 16.5 percent of the total number of fatal accidents, 15.8 percent of the total number of fatalities, 9.4 percent of the total number of nonfatal injuries, and 10.3 percent of the total aircraft dollar damage costs. The risk associated with an orientation-error accident that occurred in a RW aircraft also was most significant in that 35 percent of these accidents were fatal. The study also provides quantitative data to validate the high accident risk (not combat losses) of combat-oriented flight operations. For aircraft of all types, the mean accident rate (accidents per 100,000 flight hours) in Vietnam was approximately 2.4 times greater than the rate elsewhere for

accidents of all types, 2.1 times greater for pilot-error accidents, and 3.3 times greater for orientation-error accidents.

77-20. **The effect of nap-of-the-earth (NOE) helicopter flying on pilot blood and urine biochemicals.** July 1977. *(ADA055204)*

By David B. Anderson, Roderick J. McNeil, Martha L. Pitts, and Dorolyn A. Perez-Poveda.

Selected blood and urine chemistries were compared in helicopter pilots flying alternately nap-of-the-earth (NOE) and routine flight profiles. The NOE flights resulted in significantly higher urinary catecholamine excretion ($P<.05$), serum uric acid ($P<.05$), and blood lactic acid ($P<0.1$). Preflight cortisol was significantly higher than postflight ($P<.01$), and postflight catecholamine excretion rate was higher than during the 3-hour postflight sample period ($P<.01$). The biochemical results are consistent with the reports that NOE flight is physically more demanding in terms of muscular strain. The increased catecholamine excretion may indicate the perception of NOE flight as a more demanding and stressful activity than flight at higher altitudes. In light of previous work, the higher serum uric acid levels prior to NOE flight may provide a measure of the pilot's psychological preparation and possible performance during NOE flight.

77-21. **Physiological parameters associated with extended helicopter flight missions: An assessment of pupillographic data.** September 1977. *(ADA052771)*

By David B. Anderson and Wun C. Chiou.

Six Army aviators served as subjects in a study of various psychological and physiological parameters associated with extended helicopter flight missions. This report presents the results of the initial pupillographic data collected in this study as well as the problems encountered and the recommended solutions. It was shown that the waveform characteristics of the pupillary reflex response to light were irregular. Furthermore, the blinking frequency increased and the pupillary amplitude varied as a function of loaded flight task. Results also revealed that the average pupillary diameter was smaller in the morning than in the evening. This report recommends the future use of pupillography in which an evaluation of pilot alertness is needed.

Fiscal Year 1978

78- 1. **Biomedical evaluation of the standard M-1 and candidate personnel armor system for ground troops (PASGT) helmets---second injury evaluation.** October 1977. *(ADB022906L)*

By John D. Current.

The Personnel Armor System for Ground Troops (PASGT) helmets are candidates for replacement of the Standard A, M-1 Infantry helmet. The PASGT helmets are one-piece Kevlar laminates in two areal densities: 30 oz/sq ft and 38 oz/sq ft. The two candidate PASGT helmets were evaluated in comparison with the M-1 helmet regarding their ability to ensure helmet retention and prevent secondary injury (neck or closed head injury), when impacted by a typical nonpenetrating antipersonnel fragment projectile. It was concluded that the two candidate PASGT helmets and the M-1 helmet provided adequate protection against such secondary injury and ensured helmet retention when impacted by a typical nonpenetrating antipersonnel fragment projectile.

78- 2. **Muscle stresses induced by infantry helmets of the personnel armor system for ground troops.** October 1977. *(ADB022957L)*

By John C. Johnson and Mark S. Blackmore.

The muscular stress produced in the neck by two proposed infantry helmets was compared to that produced by the standard M-1 infantry helmet. The two proposed helmets were developed as a part of the Personnel Armor System for Ground Troops (PASGT). The lightweight PASGT helmet (30 oz/ft^2 areal density Kevlar) had a mass of 1.208 kg; the standard PASGT (38 oz/ft^2 areal density Kevlar), 1.446 kg; and the Standard M-1, 1.524 kg. Muscle stress produced in human subjects by each helmet was measured electromyographically in four positions: Prone, sitting (static), sitting (during vibration), and walking. No statistically significant differences existed between the muscle stresses produced by any of the three helmets in the prone position.

No statistically significant difference in muscle stress was found between the M-1 and either of the two PASGT helmets in any of the positions evaluated. The 38 oz/ft^2 areal density Kevlar PASGT helmet produced significantly greater muscle stress than the 30 oz/ft^2 areal density Kevlar PASGT helmet under three conditions: In the static sitting position where the difference was 1.9 percent ($p<.04$); in the sitting position with vibration, where the difference was 3.7 percent ($p<.01$); and during walking where the difference was 3.1 percent ($p=05$). These differences are considered physiologically important and are felt to play a role in cumulative fatigue

during continuous wearing of the helmets. The 30 oz/ft^2 areal density Kevlar helmet is recommended as producing the least muscle stress as indicated by this determination.

78- 3. **Comparison of analysis techniques for electromyographic data.** October 1977. *(ADA050032)*

By John C. Johnson.

Electromyography has been employed effectively to estimate the stress encountered by the forearm flexor muscles in performing a variety of functions in the static environment. Such analysis provides the basis for modification of a man-machine system in order to optimize the performance of individual tasks by reducing muscle stress. Myriad analysis methods have been proposed and employed to convert raw electromyographic data into numerical indices of stress and more specifically, muscle work. However, the type of analysis technique applied to the data can significantly affect the outcome of the experiment. In this study four methods of analysis are employed to simultaneously process electromyographic data. The methods of analysis include the following:

1. Integrated EMG (three separate time constants).
2. Root mean square voltage.
3. Peak height discrimination (three level).
4. Turns counting (two methods).

Mechanical stress input as applied to the arm of the subjects includes static load and vibration. The study reveals the comparative sensitivity of each of the techniques to changes in EMG resulting from changes in static and dynamic load on the muscles.

The conclusions of the study are:

1. The total integrated electromyographic output and the RMS value of the electromyographic output are both linear functions of applied stress.

2. Within the range of integration time constant evaluated (0.1-1.0 msec), the integrated electromyographic activity versus applied stress curve remains highly linear.

3. The peak height discrimination technique and the turns amplitude histogram are both highly sensitive to electromyographic changes induced by vibratory stimuli.

4. Peak height discrimination and turns counting techniques have a very narrow linear dynamic range and are not well suited to studies involving stress variations over a wide range of values.

78- 4. **Helmet cold conditioning: Correlation of structural temperatures in actual and simulated cold environments.** October 1977. *(ADA050033)*

By John C. Johnson and Stanley C. Knapp.

An experiment was conducted at the U.S. Army Aeromedical Research Laboratory (USAARL), to correlate the helmet thermal characteristics found in cold temperature conditioning as required by current impact test methodologies--American National Standards Institute (ANSI) Standard Z90.1 and the Department of Transportation (DOT) Motor Vehicle Safety Standard (MVS No. 218, Motorcycle Helmet 49CSR571.218)--and the thermal characteristics which occur during actual use by the wearer in a cold environment.

Four types of helmets were used in this evaluation: Sling suspension, form-fit, standard motorcycle, and short motorcycle helmets. Temperatures were taken within the helmet on top of the exterior surface of the shell and the crushable liner, at the center of the crushable liner, and at the center of the comfort liner. Data from this experiment was plotted graphically and yielded the following information: 1) Temperatures of helmets preconditioned and tested according to ANSI Standard Z90.1 and DOTMVS 218 do not correlate with temperatures of identical helmets used in the cold environment; 2) the discrepancy between helmet structure temperature following ANSI Z90.1 and DOTMVS 218 cold conditioning and testing, and simulated cold climate use, is dependent upon helmet structure type and the ambient temperature which existed during the simulated cold climate use; 3) the slope of the temperature gradients (temperatures versus depth in the helmet structure for simulated cold climate use) when compared to ANSI Z90.1 and DOTMVS 218 impact test conditions, were opposite in direction.

Under simulated cold climate use conditions the helmet is coldest on the outside and warmest on the inside. The reverse of this is true under ANSI Z90.1 and DOTMVS 218 conditions. Standard helmet impact test methodologies do not simulate potential, real world, cold climate conditions. The standard impact test methodologies are inappropriate for the determination of cold temperature dynamic response of a helmet system.

78- 5. **Visual workload of copilot/navigator during terrain flight.** December 1977. *(ADA055038)*

By Michael G. Sanders, Ronald R. Simmons, and Mark A. Hofmann.

The emphasis on aviator workload has been of primary concern to the U.S. Army aviation community since the incorporation of low altitude terrain flight techniques into the helicopter tactics repertory. Since navigation is a particularly acute problem at low altitudes, this project examined the visual workload of the navigator/copilot during terrain flight (nap-of-the-earth, contour, and low level) in a UH-1H

helicopter. The navigator's task was to: (1) Perform a map study of the prescribed course, (2) direct the pilot during the flight as to the direction of flight, altitude, and airspeed desired to transverse the course, and (3) identify hover points and checkpoints along the route which were given to the navigator in terms of six digit grid coordinates. Visual performance was measured via a modified NAC Eye Mark Recorder used in conjunction with a LOCAM high speed camera. This technique provided the means to objectively record and analyze the navigator's visual performance through the examination of: (1) Visual time inside the cockpit on flight and engine instruments, (2) time inside the cockpit on the map or other navigational aids, and (3) time outside the cockpit in various windscreen sectors.

A visual free time task was utilized to determine the amount of visual time the navigator had available, during flight over the prescribed course, for a nonflight related task. The data indicate that the navigator's normal workload was demanding; the visual free time task was utilized only 3 percent of the total time. The data also indicate that the duty of navigating required 92.2 percent of the copilot's total visual time while the engine and flight instruments were utilized only 4 percent of the time. These data are discussed in relation to the copilot's specified duties.

78- 6. **Visual performance/workload of helicopter pilots during instrument flight.** January 1978. *(ADA055424)*

By Ronald R. Simmons, Michael A. Lees, and Kent A. Kimball.

Flight under instrument flight rules (IFR) is reported to be one of the most important factors contributing to aviator fatigue during helicopter operations. This study was initiated to collect visual and psychomotor performance data in an attempt to investigate and study the general visual performance of aviators during IFR conditions. Two groups of aviators, with varied experience levels, were the subjects.

A NAC Eye Mark Recorder and the Helicopter In-flight Monitoring System were utilized to collect the required data. The results indicated, among other things, that pilot subjective opinion does not agree with objective data. Additionally, the altitude indicator and radio compass comprised over 60 percent of the pilots' total visual workload while the aircraft's status gauges were monitored less than 10 percent of the total time. These data should provide invaluable information concerning the visual requirements of pilots for safe helicopter operations.

78- 7. **The interaction of carbon-monoxide and altitude on aviator performance: Pathophysiology of exposure to carbon monoxide.** April 1978. *(ADA055212)*

By Joseph C. Denniston, Frank S. Pettyjohn, James K. Boyter, John K. Kelliher, Bruce F. Hiott, and Charles F. Piper.

A reappraisal of the interaction of carbon monoxide and altitude is presented in light of current concepts of the pathophysiology of low level exposure to carbon monoxide. The review includes a discussion of: (1) The potential sources of carbon monoxide; (2) the factors affecting the absorption, transport, and elimination of carbon monoxide; (3) the effects of carbon monoxide on human health and cognitive function; (4) the interaction of carbon monoxide and altitude, and resulting hypoxia; (5) the concept of equivalent physiological altitudes; (6) predictable effects of transient elevation in carbon monoxide; (7) limits of carbon monoxide exposure; and (8) the basic pathophysiological changes occurring with hypobaric hypoxia and/or carbon monoxide hypoxia.

78- 8. **A porcine bioassay method for analysis of thermally protective fabrics: A clinical grading system.** June 1978. *(ADA069202)*

By Thomas L. Wachtel, Francis S. Knox, III, and G. R. McCahan, Jr.

A clinical grading system of severity of cutaneous burn was developed in a porcine cutaneous burn bioassay model using a flame thermal source. From surface appearance, color, sensation, tactile response, tenacity of hair anchoring, and appearance on cut section, a progression of the severity of burn injury was developed and documented with serial still photographs, high-speed cinephotomacrography and clinical descriptions. Variations in this grading scheme were required for skin protected or partially protected with fabrics, blackened with stove polish, or deprived of its circulation.

78- 9. **Evaluation of four thermally protective fabrics using the USAARL bioassay method.** June 1978. *(ADA067351)*

By Francis S. Knox, III, Thomas L. Watchel, and George R. McCahan, Jr.

The United States Army Aeromedical Research Laboratory (USAARL) porcine cutaneous bioassay technique was used to determine what mitigating effect four thermally protective flight suit fabrics would have on fire-induced skin damage. The fabrics were 4.8 oz twill weave Nomex aramide, 4.5 oz stabilized twill weave polybenzimidazole, a 4.8 oz plain weave experimental high temperature polymer, and a 4.8 oz plain weave Nomex aramide. Each fabric sample was assayed 20 times in

each of four configurations: As a single layer in contact with the skin; as a single layer with 6.35 mm (one-fourth inch) air gap between fabric and skin; in conjunction with a cotton T-shirt with no air gaps; and finally, in conjunction with a T-shirt with a 6.35 mm air gap between T-shirt and fabric. Bare skin was used as a control.

A JP-4 fueled furnace was used as a thermal source and was adjusted to deliver a mean heat flux of 3.07 $cal/cm^2 sec$. The duration of exposure was 5 seconds. Four hundred burn sites were graded using clinical observation and microscopic techniques. Used as single layers, none of the fabrics demonstrated superiority in providing clinically significant protection. When used with a cotton T-shirt protection was improved. Protection improved progressively for all fabrics and configurations when an air gap was introduced. The experimental high temperature polymer consistently demonstrated lower heat flux transmission in all configurations but did not significantly reduce clinical burns.

78-10. **A porcine bioassay study of physiological effects of fiber and dye degradation products (FDP) on burn wound healing.** June 1978. *(ADA066990)*

By Francis S. Knox, III, Thomas L. Watchel, George R. McCahan, Jr., and Stanley C. Knapp.

Upon exposure to the thermal environment of an aircraft fire, many fire retardant fabrics off-gas fiber and dye degradation products (FDP). Condensation of these products on human skin raises questions concerning possible deleterious effects on burn wound healing. A porcine bioassay was used to study the physiological effects of FDP. Selected areas of living skin, protected by dyed aromatic polyamides and polybenzimidazole fabrics, were exposed to a thermal source adjusted to simulate a postcrash JP-4 fuel fire. Burn sites contaminated with FDP were evaluated by clinical observation and histological techniques. Healing of the burn wound was followed by recording time to begin epithelialization, time to closure of an open wound, and the amount and type of cicatrix formation. The experiment showed that each fabric has unique off-gassing products. The greatest amount of FDP was deposited on the skin when the skin was covered by a single layer of shell fabric separated by a 6.35 mm air gap. The presence of an intervening cotton T-shirt decreased the amount of FDP deposited on the skin. We found no evidence that FDP caused alterations in wound healing.

78-11. **A porcine bioassay method for analysis of thermally protective fabrics: A histopathological and burn depth grading system.** June 1978. *(ADA074735)*

By Francis S. Knox, III, Thomas L. Watchel, Walter P. Trevethan, G. R. McCahan, Jr., and R. J. Brown.

A histopathological and burn depth grading system that can be employed in a porcine bioassay of thermal injury is described. Biopsy specimens taken from burn sites, including both burned and normal skin were fixed in unbuffered formalin, embedded in Paraplast, sectioned at 6-7 microns, and stained using a Naval Aerospace Medical Research Laboratory modification of an Armed Forces Institute of Pathology hematoxylin and eosin method. Completed slides were graded by a pathologist using a scale of from 0 for no thermal damage, to 10 for thermal damage into the subcutaneous fat.

Measurements of normal epidermal thickness (A), normal dermal thickness (B), and burned dermal depth (from the epidermal-dermal border down to the damaged/normal tissue border (D-C), were made using standard optical techniques. In order to account for swelling or shrinkage at the burn site, additional measurements including (D) dermal thickness at burn site, (E) total skin thickness at the burn site, and (C) burn depth as measured from the fat/dermal border up to the junction between normal and damaged skin were subsequently made. A burn depth, corrected for shrinkage, then was calculated as follows:

$$(A+B) - C\,[(A+B)/E] = \text{corrected burn depth}$$

This shrinkage correction amounted to 40-50 percent in burns with histopathological burn grades of 9 or 10. A set of photomicrographs, one for each histopathological grade, is presented as an aid to others attempting to use this method.

This method provided the quantitative burn depths required for mathematical model development but is somewhat tedious to be used in screening thermally protective fabrics.

78-12. **Medical evaluation of sound attenuation and electro-acoustics characteristics of a prototype DH-178 protective helmet.** June 1978. *(ADB030755)*

By James H. Patterson, Jr., William R. Nelson, Ronny H. Marrow, Claude E. Hargett, Jr., and Robert T. Camp, Jr.

A medical evaluation of a prototype helmet was undertaken to determine its suitability for use as a hearing protective device around artillery systems. The real-ear sound attenuation of the DH-178 used alone and in combination with E-A-R earplugs was determined. The combination was found to provide exceptionally good

attenuation. Distortion measurements and speech intelligibility measurements were made using the "talk-through" circuit which is integral to this helmet. The distortion of the circuit was found to be excessive and the speech intelligibility was somewhat degraded. The "talk-through" circuit of this prototype is not considered to be "state-of-the-art."

78-13. **Evaluation of Dragon antitank weapon for toxic gases while firing from an enclosure.** May 1978. *(ADB032474L)*

By Gary D. Pollard, James K. Boyter, and Jeffrey Watson.

Toxic gases evolving from the Dragon light antitank weapon have been measured. This paper describes the way this measurement was accomplished and the results thereof. In addition, a computer treatment of the response of a gas cell of an infrared analyzer to changing concentrations of gas with time is described in detail. This computer model was applied to the Dragon data.

78-14. **An evaluation of perceptual-motor workload during a helicopter hover maneuver.** May 1978. *(ADA058016)*

By Michael G. Sanders, Raymond T. Burden, Jr., R. R. Simmons, M. A. Lees, and K. A. Kimball.

Stability augmentation systems are purported to reduce pilot workload during hover, nap-of-the-earth, and IFR maneuvers. The current research project examines a method of aiding the MEDEVAC pilot in performing a hover maneuver while perhaps reducing workload. A modular, four-axes stability augmentation system (Ministab) with integrated rate attitude and heading retention was installed on the USAARL JUH-1H helicopter. Participating personnel in the project were nine U.S. Army aviators with a total average of 1,172 flight hours. The aviators hovered at 30 feet above ground level for 5 minutes under each of the following flight control conditions: (1) Unaided--"normal" hover with visual flight rule conditions, (2) using Force Trim, and (3) using the Ministab.

Continuous information from 20 pilot and aircraft monitoring points were recorded on an incremental digit recorder for all flights. Multivariate analyses were performed on both aircraft status variables and control input workload/activity measures. Under the conditions tested, the stability augmentation system evaluated did not provide a clear cut improvement in flight performance and workload across all flight parameters.

78-15. **Mathematical models of skin burns induced by simulated postcrash fires as aids in thermal protective clothing design and selection.** June 1978. *(ADA066946)*

By Francis S. Knox, III, Thomas L. Wachtel, and Stanley C. Knapp.

The design and selection of thermal protective clothing takes into account many factors, e.g., appearance, comfort, durability, cost, and thermal protective capability. To aid in determining the appropriate balance among these factors, thermal protective capability must be measured in a quantitative and clinically meaningful way. To provide such a valid assessment of thermal protective capability, two mathematical models were developed to predict skin burn damage based on data derived from 95 domestic white pigs exposed to simulated postcrash fires. The first model, a multi-discriminate statistical model derived from experimental data, was used to determine the importance of many variables, e.g., incident heat flux, exposure time, initial skin temperature, and color of the skin.

The second, an analytical model, assumes that tissue damage proceeds as a first order chemical reaction dependent on tissue temperature, and that total damage is merely the time integral of tissue damage during heating and cooling. It also takes into account tissue water boiling and thermal shrinkage which alter burn depth in more severe burns. The predicted burn depths from measurements of thermal energy transfer through or emanating from burning fabrics when combined with burn area, age, and sex yield predicted survivability. Predictions of changes in survivability allow rational judgments to be made regarding the effectiveness of implementing proposed flight suit clothing fabric and design changes.

Progress toward supplanting the USAARL bioassay method for thermal fabric evaluation by laboratory methods involving heat sensors and a mathematical model is encouraging. Implementation will require minor changes in the analytical model, BRNSIM, to make its output conform more closely to observed tissue temperatures and will require the addition of a routine to convert sensor temperatures to heat flux. Consideration of survivability will require more precise clinical data relating burn depth to clinical outcome.

Fiscal Year 1979

79- 1. **U.S. Army aviation fatigue-related accidents, 1971-1977.** October 1978. *(ADA062486)*

By Gerald P. Krueger and Yvonna F. Jones.

An accident data survey was made to determine how frequently aviator crew fatigue may have contributed to U.S. Army aviation accidents from 1971 to 1977.

All accident reports in the U.S. Army Agency for Aviation Safety (USAAAVS) database were reviewed. Aviator fatigue was deemed to be a contributing factor in 42 rotary-wing accidents which resulted in a total of 51 fatalities and 63 personnel injuries. Fatigue contributed to 10 fixed-wing accidents, resulting in three fatalities and five injuries. This paper categorizes these fatigue-related accidents by aircraft and mission type and by time of day and day of week of the accident. It also tabulates pilot activities prior to the accidents which promote the likelihood of pilot fatigue contributions. The personnel and equipment costs of these accidents to the Army are estimated, and the relative importance of such accidents to the total U.S. Army aviation accident picture is assessed.

79- 2. **Blast overpressures produced by prototype XM198, 155 mm towed howitzer.** December 1978. *(ADB049328L)*

By James H. Patterson, Jr., and Ben T. Mozo.

In order to further clarify the nature of the blast overpressure problem associated with firing the M203 zone 8 propelling charge in the M198, 155 mm howitzer, measurements were obtained around a prototype cannon during test firing at Yuma Proving Ground, Arizona, in April 1977. Results of these measurements indicate that the blast overpressures for the zone 8 charge exceed the highest limit allowed by MIL-STD-1474A (MI) at normal crew positions for quadrant elevations of 45, 267, and 800 mils. It is recommended that restrictions be placed on the exposure of personnel to these blast waves until further research is accomplished to elucidate the nature and extent of hazard involvement.

79- 3. **High-frequency hearing loss incurred by exposure to low-frequency noise.** January 1979. *(ADA056415)*

By Charles K. Burdick, James H. Patterson, Jr., Ben T. Mozo, and Robert T. Camp, Jr.

Damage-risk criteria for exposure to continuous noise are expressed in terms of A-weighted levels rather than unweighted, absolute sound pressure levels. A-weighting deemphasizes or reduces the levels of low-frequency noise. Damage-risk criteria using A-weighted levels assume that high-intensity, low-frequency noise is not as hazardous to hearing as high-intensity, high frequency noise. Groups of chinchillas and humans were exposed to octave bands of noise to test this assumption. Chinchillas exposed to low-frequency noise incurred permanent high-frequency hearing losses and humans exposed to low-frequency noise for a short duration incurred temporary high-frequency threshold shifts. The experiments indicate that high-intensity, low-frequency noise may be a hazard to hearing that was previously unrecognized and raise questions concerning the adequacy of current damage-risk criteria to deal effectively with low-frequency noise.

79- 4. **A fire simulator/shutter system for testing protective fabrics and calibrating thermal sensors.** March 1979. *(ADA082964)*

By F. S. Knox, III, P. W. Sauermilch, T. L. Wachtel, G. R. McCahan, Jr., W. P. Trevethan, C. B. Lum, R. J. Brown, and L. A. Alford.

The design, construction, calibration, and use of a JP-4 fueled, shuttered furnace is described. Based on a NASA design, this furnace simulates the radiative and convective thermal environment of a postcrash fire in rotary-wing aircraft. Heat fluxes ranged from 0.5 to 3.6 ±3 percent calories per square centimeter per second with steady-state furnace wall temperatures from 519 C (967 F) to 1353 C (2450 F) and a radiative/total flux ratio of approximately 0.5. A pneumatically-propelled, water cooled shutter, mounted in a rolling animal carrier, controlled the exposure of pigs and thermal sensors to the fire. An electronic data acquisition and control system also is described. This system automatically controlled the opening and closing of the shutter and provided strip chart and FM magnetic tape records of exposure time, furnace wall temperature, heat flux, and sensor output. Sources of error including nonuniformity of flame front and shutter dynamics are discussed. Methods of animal handling, burn grading, and photographic documentation are introduced along with a brief description of some nine experimental protocols carried out using this fire simulator shutter system.

79- 5. **How to measure the burn-preventive capability of nonflammable textiles: A comparison of the USAARL porcine bioassay technique with mathematical models.** March 1979. *(ADA069271)*

By Francis S. Knox, III, Thomas L. Wachtel, and Stanley C. Knapp.

Nonflammable fabrics are used extensively as an insulating thermal barrier to protect the wearer from injury from an extrinsic thermal source. The U.S. Army Aeromedical Research Laboratory (USAARL) porcine cutaneous bioassay technique has been used to determine the burn prevention capabilities of nonflammable fabrics. The results of this technique correlate well with clinical observations, but are logistically difficult and expensive to conduct. The ideal method for testing fabric samples would be to use a physical thermal sensor to measure the heat flux transmitted through or emanating from a fabric and convert this measured heat flux to a predicted burn depth. This paper presents the data from over 1500 burn sites on 95 domestic white pigs in which the bioassay method was used in conjunction with calorimeters exposed to the same fire. Two mathematical models, one analytic and the other empirical, are described. The results of these models are compared with the results of the bioassay technique in the evaluation of four nonflammable fabrics. The comparison shows that the models are efficient tools for routine evaluation of nonflammable fabrics. The models provide a basis from which to develop better test methods for children's sleepwear, nursing home textiles, and other thermally protective fabrics.

79- 6. **Threshold shifts in chinchillas exposed to octave bands of noise centered at 63 and 1000 Hz for 3 days.** March 1979. *(ADA955945)*

By Charles K. Burdick, James H. Patterson, Jr., Ben T. Mozo, and Robert T. Camp, Jr.

Audiograms were obtained on eight binaural chinchillas trained on a shuttlebox avoidance procedure. Four of the animals were exposed to three successive levels of an octave band of noise centered at 63 Hz: 100 dB SPL (74 dBA), 110 dB SPL (84 dBA), and 120 dB SPL (94 dBA). The other four animals also were exposed to three successive levels of an octave band of noise centered at 1000 Hz: 75 dB SPL (75 dBA), 85 dB SPL (85 dBA), and 95 dB SPL (95 dBA). All exposure durations were 72 h. Little threshold shift (TS) resulted from the lower two exposure levels in the 63-Hz noise band. At the 120 dB SPL (94 dBA) exposure levels, maximum TS of 43 dB occurred at 2000 Hz. Permanent threshold shifts (PTSs) of 16 dB at 2000 Hz and 11 dB at 1400 Hz were found. For the 1000-Hz exposures, TSs of 20, 45, and 61 dB were found at the successive exposure levels at 1400 Hz. The 95 dB SPL (95 dBA) exposure level resulted in PTSs of 6 dB at 1400 Hz and 9 dB at 2000 Hz. The major results were: (1) A high-frequency hearing loss to a low-frequency noise. (2) Noise bands matched within 1 dBA were not equally hazardous as dictated by damage-risk criteria. The 63-Hz noise band produced nearly twice the PTS of the 1000-Hz noise band.

79- 7. **Normal blood chemistry values for laboratory animals analyzed by the sequential multiple channel analyzer computer (SMAC-20).** February 1979. *(ADA067951)*

By Russell L. Johnson, Terry Gee, and Frank Pettyjohn.

Sequential Multiple Channel Analyzer Computers are rapidly becoming common diagnostic tools of both physicians and veterinarians in medical and research facilities. This increased use requires a reappraisal of normal serum values presently established for standard diagnostic tests. This report establishes normal serum values for laboratory animals to include dogs, mice, miniature swine, and horses. In addition, comparisons are made between age, sex, and age and sex in the dog to show probable discrepancies in the use of standard normal values.

79- 8. **In-flight performance evaluation of experimental information displays.** May 1979. *(ADA071701)*

By Michael A. Lees, Michael G. Sanders, Raymond T. Burden, Jr., and Kent A. Kimball.

The objective of this investigation was to evaluate a method of displaying infor-

mation which permits rapid transmission of flight data to the operator under three viewing conditions: (1) Day flights with the unaided eye, (2) night flights with the unaided eye, and (3) night flights using the AN/PVS-5 night vision goggles (40 degrees field-of-view focused at infinity). Information obtained from the analyses of aviator performance data demonstrated the potential of presenting flight information to the aircrew via prototype displays for all viewing modes.

79- 9. **Head aiming/tracking accuracy in a helicopter environment.** May 1979. *(ADA071359)*

By Robert W. Verona, John C. Johnson, and Heber Jones.

This experiment was conducted to measure man's head aiming/tracking capability using a helmet mounted sighting device. The influences of target speed, helmet suspension types, and helmet weighing parameters on head aiming/tracking were investigated. If the aiming/tracking accuracy was sensitive to manipulation of these man-machine interface parameters, then it would seem to indicate that improved aiming/tracking accuracy could be obtained by improving the interface.

The factors analyzed were eye dominance, helmet weighing, target speed, and helmet suspension. The eye dominance, helmet weighing, and target speed factors were statistically significant; however, the only factor of practical significance was target speed. A subject aiming at a static target with his head had a RMS error of about 3 milliradians. When the target began to move 4 degrees/second, the error in-creased to about 10.5 milliradians. When the subject began to vibrate too, the error increased to 13 milliradians. When the target speed doubled, the vibrating error increased to 16.8 milliradians.

79-10. **Real-ear sound attenuation measurement of selected sound protectors identified in the DAF qualified products list.** June 1979. *(ADB039609L)*

By Jerod Goldstein, James H. Patterson, Jr., Robert T. Camp, Jr., William R. Nelson, Claude E. Hargett, and Barbara Murphy.

Nine hearing protectors available under the qualified products list were evaluated for their attenuation properties. Only one earmuff, the Mine Safety Mark II Noisefoe met the MIL-P-38268B standard of 17 June 1971. None of the Type II earmuffs met the standard in the three wearing positions. The protection provided by the Type II muffs was insufficient in the three wearing positions. The AES ranged from 28.5 at the low end to 73.9 at the high end indicating a varied range of protection provided by the Type II earmuff. Recommendations are provided concerning the use of these hearing protective devices.

79-11. **A human performance/workload evaluation of the AN/PVS-5 bifocal night vision goggles.** July 1979. *(ADA071882)*

By Lewis W. Stone, Michael G. Sanders, David D. Glick, Roger W. Wiley, and Kent A. Kimball.

Eight experienced U.S. Army aviators performed various maneuvers in an instrumented helicopter to test the relative usability of two bifocally configured night vision goggles. Both configurations were statistically better than the unmodified arrangement when looking at a pilot's ability to hold a precise altitude at night. The subjective data, supported by flight performance observed between the two bifocals, further suggested that a 24 percent bifocal version was more desirable than a 14 percent configuration. The inference is that the reduced inside field-of-view presented by the 14 percent bifocal interferes with a pilot's ability to rapidly locate instruments once he has directed his attention inside the cockpit.

79-12. **The measurement of man-helicopter performance as a function of extended flight requirements and aviation fatigue.** July 1979. *(ADA074541)*

By Michael A. Lees, Lewis W. Stone, Heber D. Jones, Kent A. Kimball, and David B. Anderson.

Field commanders have long been concerned about the impact of fatigue on aviator effectiveness, especially where aviators are called upon to fly numerous successive stress-related missions (e.g., combat and/or rescue work). At present there is little specific information upon which the commander can base his crew rest decisions. The U.S. Army Aeromedical Research Laboratory (USAARL) sought to answer this need by observing pilots in an actual flight situation. In this study six pilots flew in a helicopter for 11.5 hours per day for 5 days with 3.5 hours of sleep per day. Data collection included biochemical, visual, psychological, and in-flight measurements. This report includes a critical literature review and describes the methodology of the study. It is intended to serve as a detailed background for the analyses to follow.

79-13. **Medical evaluation of sound attenuation and electroacoustics characteristics of a NATO (COSMOCORD) peak limiting ear protector.** July 1979. *(ADB040821L)*

By James H. Patterson, Jr., William R. Nelson, Ronny H. Marrow, Claude E. Hargett, Jr., and Robert T. Camp, Jr.

A medical evaluation of a Cosmocord peak limiting ear protector was undertaken to determine its suitability for use as a hearing protective device around artillery systems. The real-ear sound attenuation of the Cosmocord used alone and in

combination with the E-A-R earplugs was determined. The combination was found to provide exceptionally good attenuation. Distortion measurements and speech intelligibility were made using the "talk through" circuit which is integral to this device. The distortion of the circuit was found to be excessive and the speech intelligibility was somewhat degraded. The "talk through" circuit of this device is not considered to be "state-of-the-art."

79-14. **A direct measure of CRT image quality**. September 1979. *(ADA075610)*

By Robert W. Verona, Harry L. Task, Victor C. Arnold, and James H. Brindle.

This paper describes a direct measuring technique for determining the image quality of raster-scanned cathode-ray tube (CRT) displays. This technique is based on the Modulation Transfer Function (MTF) theory and human visual psychological data. The rationale for the technique is discussed from a theoretical as well as functional viewpoint. The instrumentation necessary to obtain these measures in manual and automatic modes is discussed. Data obtained using this measurement technique are analyzed and compared with the theoretical performance of the displays. The image quality of the new CRT displays procured for the U.S. Army's Advanced Attack Helicopter is being specified and tested using this direct measuring technique.

Fiscal Year 1980

80- 1. **Aeromedical aspects of CH-47C helicopter self-deployment (Operation Northern Leap)**. March 1980. *(ADA083736)*

By Lawrence R. Whitehurst and Aaron W. Schopper.

In August 1979, the U.S. Army accomplished its first trans-Atlantic helicopter flight. Four CH-47C helicopters departed Fort Carson, Colorado, and landed in Heidelberg, Germany, with intermediate stops in Iowa, Pennsylvania, Maine, Canada, Greenland, Iceland, and England. A flight surgeon accompanied the mission to provide medical support and assess aircrew workload, stress, and fatigue. Direct observation, interviews, and questionnaires were used to gather data.

Respiratory infections were experienced by approximately 50 percent of the mission crew during the 14-day journey. These were attributed to wide climate variations and inadequate crew rest during the first half of the mission. Daily preflight questionnaires showed highest levels of stress occurred at the start of the mission and decreased to a constant level once the mission was underway. Daily postflight data demonstrated that cockpit workload increased appreciably with deterioration of weather during the latter part of the mission. Time at the flight controls and mission conditions during flight were found to be the greatest contributors to pilot

fatigue; whereas, crew chiefs reported frequent time zone changes and poor facilities at stopover points to be their greatest causes of fatigue. The results demonstrated the feasibility of self-deployment and the need for medical support of such missions.

80- 2. **Conferencing and teleconferencing in three communication modes as a function of the number of conferees.** (Reprint), July 1980. *(ADA089085)*

By Gerald P. Krueger and Alphonse Chapanis.

Nine groups of 2, 3, and 4 students each, 27 groups in all, discussed topics face-to-face or in one of two teleconference modes: Teletype and televoice. Each group used only 1 of the 3 communication modes to solve a different problem on each of 3 successive days. Each problem encouraged opinionated discussion and required the group to arrive at a consensus about certain topical issues. Group size had no effect on time to solution or on the solutions themselves, but an increase in group size resulted in an increase in almost every group measure of communication. The larger groups used more messages, more words, communicated faster, and exhibited greater relative variability among the numbers of messages generated by the individuals within groups than did the smaller groups. Equivalent solutions also were reached in all communication modes, but subjects in face-to-face conferences used more messages and words than did subjects in either of the telecommunication modes. Communication rates were much higher and solutions were reached much faster in the two conference modes that had a voice channel, i.e., face-to-face and televoice, than in the teletype mode. Few practice effects were found.

80- 3. **Preliminary evaluation of the blast overpressure field around the M198, 155 mm howitzer firing the M2031 propelling charge.** October 1979. *(ADB042794L)*

By James H. Patterson, Jr., Ben T. Mozo, and Ronny H. Marrow.

This report contains blast overpressure data from the M198, 155mm howitzer firing the M203E1 charge. The blast data were analyzed for peak pressure and B-duration for comparison with MIL-STD-1474A (MI). From these results contour maps showing the regions bounded by the X, Y, and Z limit of the MIL Standard were derived.

80- 4. **Contaminants found in the JUH-1H and JU-21G aircraft bleed air.** December 1979. *(ADB051360L)*

By Gary D. Pollard, Jonathan P. Stroud, Robert L. Barr, and Melissa R. Sanocki.

Traces of hydrocarbon contaminants were found in heater air of bleed air systems on several Army aircraft. The contaminants were detected by infrared spectroscopy and mass spectrometry. Problems of detection and quantitation are discussed.

80- 5. **Common problems in the medical care of pilots.** (Reprint), March 1980. *(ADA086252)*

By Lawrence R. Whitehurst.

Family physicians need to have an increased awareness of the medical needs of pilots. A close, trusting relationship is essential. Special consideration must be given when prescribing medications. Hypoxia is a special problem for pilots with cardiovascular and/or respiratory diseases. Several medical problems may occur because of rapid changes in barometric pressure, including barotitis media, which is best treated in flight. Minor ailments, use of alcohol and smoking may become serious problems for aviators, therefore patient education is important.

80- 6. **Attenuation variation obtained with training while utilizing an in-the-ear protective device.** March 1980. *(ADA084409)*

By Jerod L. Goldstein and Barbara Murphy.

This study attempted to determine the importance of training in the use of a specific hearing protective device, the E.A.R. earplug, which is considered a universal fit hearing protective device. The results of the study indicated that training in the use of E.A.R. earplug is important and must be continually emphasized to provide maximal attenuation with the E.A.R. earplug.

80- 7. **SPH-4 helmet damage and head injury correlation.** September 1980. *(ADA090750)*

By Bruce A. Slobodnik.

Human tolerance to head impact was assessed by correlating the force levels required to duplicate damage seen in 12 SPH-4 aviator helmets retrieved from U.S. Army helicopter crashes with resulting head injury. Head injury occurred at peak acceleration levels far below 400 G, which is the value currently used by the U.S.

Army as the pass-fail criterion in evaluating the impact attenuation performance of prospective aircrew helmets. Concussive head injuries occurred below Severity Index values of 1500 and below Head Injury Criterion values of 1000. These are considered concussive threshold values by the National Operating Committee on Standards for Athletic Equipment and by the Department of Transportation, respectively.

80- 8. **Evaluation of Army aviator human factors (fatigue) in a high threat environment.** September 1980. *(ADA090751)*

By Chester E. Duncan, Michael G. Sanders, and Kent A. Kimball.

Questionnaire data received from student and instructor pilots located at Fort Rucker, Alabama, indicate significant levels of fatigue when flying in different flight altitudes and profiles; the lower the altitude flown, the more rapidly pilots experience fatigue. These data suggest night standard flight is 1.4 times as fatiguing as day standard flight; day terrain flight is 1.3 times as fatiguing as day standard flight; and night terrain flight, the most difficult flight profile examined, is 1.97 times as fatiguing as day standard flight. Army Regulation 95-1, 1 January 1980, sets a maximum of 140 hours per month per aviator of day flight in a combat environment. Existing doctrine emphasizes nap-of-the-earth techniques, and if so accomplished for 140 hours could possibly result in an unsafe and severely fatigued helicopter pilot. Field commanders utilizing the guidelines presented in this report may organize and more effectively continue their mission in Army aviation.

Fiscal Year 1981

81- 1. **Aeromedical factors in aviator fatigue, crew work/rest schedules, and extended flight operations: An annotated bibliography.** January 1981. *(ADA096552)*

By Gerald P. Krueger and James N. Fagg.

The influence of aviator fatigue on sustained flight operations is an important aeromedical topic. Available research data on the topic are either in short supply or are scattered throughout diverse printed sources and are difficult to tap when questions of their application to operational decisions are posed. This annotated bibliography lists 224 references containing research data, conceptual position papers, and different methodological approaches to studying aviator fatigue, aviation crew work-rest schedules, and extended flight operations. The bibliography contains an index which categorizes the references into such categories as: (1) Circadian rhythms and jet lag; (2) psychological measurement of performance; (3) helicopter, transport, and civilian flight operations; (4) crew work/rest schedules; and (5)

biochemical and physiological indices of fatigue. The basic period of coverage is 1940-1980.

81- 2. **When the grand tour's a grind.** (Reprint), September 1981. *(ADA106818)*

By Stanley C. Knapp.

Americans are traveling more and, in the view of many observers, enjoying it less. Modern jet travel, along with the necessity or desire to see as many tourist sights or conduct as many business meetings as possible in a single day, serve to create a well-defined but often overlooked symptom complex called travel stress. Travel stress is the complex interaction of a number of environmental, physiological, and psychological stressors. Disruptions in the traveler's circadian rhythm, changes in dietary stimulants and alcohol, and the pressure of trying to get the most for one's travel dollar impact the health and the efficiency of the traveler. This paper outlines proven and practical pretravel prevention techniques and enroute therapy.

81- 3. **Vibration in a helmet mounted sight (HMS) using mechanical linkage.** March 1981. *(ADA098533)*

By John C. Johnson, David B. Priser, and Robert W. Verona.

The purpose of this experiment was to determine the extent to which aircraft vibration was coupled to a crewman's flight helmet by the mechanical linkage of a helmet-mounted sight (Fire Control Subsystem, Helmet Directed, XM-128). Two variations of the SPH-4 flight helmet were tested: 1. SPH-4 with standard web suspension; 2. SPH-4 with a formfit foam liner suspension. The system was tested in the front seat of an AH-1S "Cobra" helicopter. Five flight conditions were used in the experiment: 1. Hover; 2. 40kn; 3. 80 kn; 4. 120kn; and 5. standard left turn. Two conditions of the helmet-mounted control linkage were tested: 1. Connected and 2. disconnected. A triaxial accelerometer was mounted on top of the flight helmet to measure vibration. The data were analyzed using a fast Fourier transform analyzer and a desktop computer. The following observations were made: 1. Both helmets vibrate more with the sight attached. 2. The response to the sight coupled vibration of the standard SPH-4 differed from that of the form-fit SPH-4. 3. The form fit SPH-4 helmet vibrated more in a narrow band centered at about 30 Hz. 4. The standard SPH-4 helmet vibrated more over a wide band of frequencies above 30 Hz. Based on a review of published literature with respect to known or probable physiological problems related to the effects of vibration, we concluded that the significant increase in vibration of the helmet caused by the mechanical sight linkage may be expected to degrade pilot/gunner visual performance and hearing acuity, and increase fatigue rate to some extent. Insufficient data currently is available to predict the magnitude of performance degradation which could result from increases in helmet vibrations.

81- 4. **Helicopter crashworthy fuel systems and their effectiveness in preventing thermal injury.** (Reprint), July 1981. *(ADA102198)*

By Stanley C. Knapp, Pierre Allemond, and David H. Karney.

In 1968, the United States Army committed itself to a goal of eliminating postcrash fires in survivable helicopter accidents. New helicopters manufactured after 1970 were equipped with a crashworthy fuel system, and an extensive retrofit program of older aircraft was begun. This paper reviews all Army helicopter accidents during the period 1968-1976 and classifies them by survivability and whether or not the aircraft was equipped with a crashworthy fuel system. Accident-associated fatalities and injuries were reclassified as to the primary injury involved and its relationship to the existence of any postcrash fire. The direct costs involved in the care of thermal fatalities and thermal injuries were calculated using the most conservative estimates. It is shown that the helicopter crashworthy fuel system essentially eliminated postcrash fatalities and injuries in accidents involving helicopters equipped with the new system.

81- 5. **Vibration levels in Army helicopter--measurement recommendations and data.** September 1981. *(ADA108131)*

By John C. Johnson and David B. Priser.

We reviewed literature on vibration levels found in currently-fielded helicopters in order to prepare a comparative summary of vibration exposure levels at crew stations and of the test methods used to measure these levels. This effect was initiated at the request of the Air Standardization Coordinating Committee (ASCC) Working Party 61 and because of the wide variety of methods used in data capture and instrumentation documentation. Sources in literature reviewed included technical reports of U.S. Government agencies and papers in open literature. Articles were reviewed based upon three criteria: (1) Quantitative description of vibration in currently-fielded U.S. Army rotary-winged aircraft, (2) article contents are unclassified and available for publication in open literature, and (3) article describes human exposure levels in aircraft vibration.

The results of this review are in the form of abstracts of 10 articles that met the criteria. Graphic data excerpted from these papers were combined to form eight graphs from which to make comparisons and conclusions.

In addition to providing summary abstracts and data, we have written a critique of vibration test methods. We have suggested some guidelines for measuring vibration and for presenting the resulting data, placing emphasis on documentation of test methods and instrumentation.

81- 6. **Computer model for the evaluation of symbology contrast in the integrated helmet and display sighting system.** September 1981. *(ADr ,61188L)*

By Clarence E. Rash, Daniel R. Monroe, and Robert W. Verona.

A computer model which simulates the optical transmittance and reflectance properties of the Integrated Helmet and Display Sighting System (IHADSS) is presented. Using a limited database consisting of the spectral transmittance and reflectance curves of the various IHADSS's components, standard Figures-of-Merit are calculated and presented as a measure of the daylight visibility of the IHADSS symbology. The model also provides the software for continuous updating of the database.

81- 7. **Operator's manual for variable weight, variable CG helmet simulator.** (Reprint), September 1981. *(ADA221421)*

By Craig M. Svoboda and James C. Warrick.

A variable weight, variable CG helmet simulator has been designed to measure the effect of U.S. Army headgear on muscle loading and fatigue. The helmet simulator consists of two weight concealment boxes attached to opposite sides of a supporting head which in turn is mounted on the wearer's head by a suspension system taken from an SPH-4 helmet. The weight and CG can be altered by positioning variable weights within the concealment boxes.

Fiscal Year 1982

82- 1. **Direct and neighboring sensitivity changes produced by red and blue-white adapting fields.** February 1982. *(ADA111880)*

By Franklin F. Holly and Virgil R. Rogers.

Observers viewed Army instrument panel lighting red and Air Force instrument panel lighting blue-white adaptation fields and their thresholds were determined both within the adapatation field and outside of it. In some cases, thresholds were determined while the adaptation field was still on and in other cases they were determined after the adaptation fields had been off for 10 seconds. Also, some trials were performed under otherwise totally dark ambient conditions and other trials were performed under an ambient illumination which simulated that produced by a full moon on a clear night. It was found that under ambient conditions of total darkness thresholds were lower with the red adaptation field than with the blue-white. With the full moon ambient illumination the results were more varied. When the trials were performed after the adaptation field had been turned off, there

were generally no differences between the thresholds produced by the red adaptation field and those produced by the blue-white adaptation field. On the other hand, when trials were performed with the adaptation field still on, there was an interaction such that thresholds were lower with the blue-white field at the smallest adaptation field intensities or with the red field at the greatest adaptation field intensities. The results were discussed in terms of their significance for aircraft lighting and the possible roles played by stray light and other underlying processes.

82- 2. **Analysis of U.S. Army aviation mishap injury patterns.** (Reprint), April 1982. *(ADA113610)*

By James E. Hicks, Billy H. Adams, and Dennis F. Shanahan.

Recent advances in U.S. Army procedures for the identification and reporting of personnel injuries resulting from aircraft mishaps are reviewed. Mishap injury data requirements based on the needs of retrospective and prospective analyses are discussed. The requirement for these analyses to support engineering management decisions that will implement remedial programs to correct identified crashworthiness deficiencies is discussed. This paper summarizes the U.S. Army process for gathering aviation mishap injury data, describes modifications to procedures and codes for recording injury data, and provides examples of use of the data resulting in fleetwide improvement programs.

82- 3. **Studies of aural nonlineraity and the mechanisms of auditory fatigue. Part II: Epidemiologic methods in noise-induced hearing loss.** (Reprint), April 1982. *(ADA221134)*

By John Erdreich and Linda Erdreich.

This report is a tutorial on epidemiological methods with specific references to potential application to studying noise-induced hearing loss.

82- 4. **Comparative evaluation of SPH-4 helmets from DLA 100-80-C-2226 and DLA 100-78C-1041.** April 1982. *(ADB064442L)*

By Joseph L. Haley, Jr., William E. McLean, and Ben T. Mozo.

At the request of Fort Rucker's Directorate of Industrial Operations, SPH-4 helmets from the Defense Logistics Agency (DLA) Contract 100-80-C-2226 (Aqua-Aire) and DLA 100-78C-1041 (Astrocom) were evaluated in accordance with applicable military specifications and drawings. The helmets tested met the noise attenuation specifications, except at 75 Hz for the Aqua-Aire and at 3 kHz for the Astro-

com helmet. The Aqua-Aire helmet visors failed to meet the specifications for optical distortion, abrasion resistance, and end item examination. One of the two Aqua-Aire helmets and two Astrocom helmets which were impact tested failed to meet the impact specification. The Aqua-Aire helmets failed to meet the specifications for chin strap retention strength, shell dimensional measurements, shell construction, microphone swivel attachments, and visual examination of completed assembly.

82- 5. **Oscillations in the visual response to pulsed stimuli.** June 1982. *(ADA117428)*

By Franklin F. Holly.

Dunlap (1915) reported a phenomenon in which a single photic pulse, presented in the periphery under mesopic conditions, is perceived as two sequential flashes. The present work indicates that this double-flash effect is but a special case of a class of auto-oscillatory phenomena occurring at a frequency in the neighborhood of 10 Hz. Flicker studies by several investigators (e.g., de Lange, 1958) have indicated a resonance (temporal MTF peak) at approximately 10 Hz. It is believed that the frequency of the oscillatory phenomena described here results from the natural frequency of the network responsible for this peak. It also is believed that these phenomena are related to the oscillatory potentials which have been recorded from retina and cortex. The impetus for this work was provided by the need to explicate certain oscillatory phenomena which had been noted in the course of evaluating proposed lighting systems on new Army helicopters.

82- 6. **Pursuit rotor tracking performance in conjunction with extended flight operations in a helicopter simulator.** August 1982. *(ADA119237)*

By Lewis W. Stone, Gerald P. Krueger, and William R. Holt.

Six U.S. Army Initial Entry Rotary-Wing School graduates participated as subjects in a week-long study to examine the effects of extended simulated helicopter operations on pursuit tracking skills. Using a photoelectric rotary pursuit device, three fixed patterns (a square, a circle, and a triangle) were presented to each subject three times daily for 5 days. An analysis of the results revealed a significant difference in subject performance between patterns. It also revealed a statistically significant difference in performance over days on one of the patterns--the triangle. The thread woven through these results seemed to be one of relative complexity. It suggested that the effects of sustained operations interfered with the aviator's ability to fully integrate his mental and psychomotor skills in order to meet the requirements of a more complex task.

82- 7. **Preliminary study on scanning techniques use by U.S. Coast Guard lookouts during search and rescue missions.** August 1982. *(ADA120597)*

By N. Joan Blackwell, Ronald R. Simmons, and Jimmie R. Watson.

This research was a cooperative study undertaken by the U.S. Coast Guard Research and Development Center (USCG R&D) and the U.S. Army Aeromedical Research Laboratory (USAARL). Eye performance data were collected from Coast Guard personnel performing as lookouts during simulated search and rescue missions on HH-3F helicopters, a 210-foot cutter, and an 82-foot cutter. Visual performance was measured by means of NAC Eye Mark Recorder Systems during the Winter 1981 Visual Detection Experiment conducted by the USCG R&D Center in the Gulf of Mexico off of Panama City, Florida, during January and February 1981. The visual performance measures were analyzed to determine the scanning patterns utilized by the various lookouts. Based upon this initial study, it appears that most personnel spend about one-half of search time on only one segment of their total assigned viewing area. For example, pilots and copilots spend most of their time looking out their respective front windows. For the surface vessels, the subjects seemed to display the condition termed "eye lock" ---that is, a lookout would position his eyes and keep them stationary, allowing the movement of the search vessel to dictate his scan path. The scanner patterns prescribed in the U.S. Coast Guard training manuals were used infrequently; rather the observers followed the outline of structures within their fields-of-view.

82- 8. **Comparison of helicopter copilot workload while using three navigation systems during nap-of-the-earth flight.** August 1982. *(ADA120501)*

By David O. Cote, Gerald P. Krueger, and Ronald R. Simmons.

Three different generic navigation systems were examined for their effects on helicopter copilot/navigator workload and performance during nap-of-the-earth (NOE) flight. The navigation systems examined were: (1) The conventional 1:50,000 scale topographic hand-held map; (2) a Doppler navigation system in conjunction with a hand-held map; and (3) a projected map system driven by Doppler signals in conjunction with a hand-held map. Eighteen pilots performed copilot/navigator duties in an Army JU-1H utility helicopter flown by a laboratory research pilot. Data collected included measures of navigation performance, pilot-copilot communications, and copilot/navigator eye movements.

The results indicate that automatic navigation systems like the ones used here improve navigation performance by enabling the aircrew to reach their destination with reduced in-flight delays, at a faster airspeed, and with fewer and smaller navigation errors. The number of verbal exchanges between the copilot and pilot was reduced when using the Doppler system versus the hand-held map alone. Subjects who used the Doppler system also spent less time navigating.

When using a projected map system, copilot/navigators experienced a lower level of visual workload and spent 10 percent more time looking outside the cockpit. With all navigation systems, more than 80 percent of the copilot's time was spent navigating, over 20 percent of the aircrew's time was spent in navigation communications, and less than 10 percent of their time was visual "free time" that could be used to attend to other tasks.

82- 9. **Performance impact of current United States and United Kingdom aircrew chemical defense ensembles.** September 1982. *(ADA121502)*

By Bruce E. Hamilton, Dennis Folds, and Ronald R. Simmons.

Six male volunteers from the graduate entry level flight program at the U.S. Army Aviation Center (USAAVNC), Fort Rucker, Alabama, served as subjects in an investigation of the ability of helicopter pilots to fly while wearing chemical defense (CD) ensembles in hot weather. Each subject flew on three separate days, wearing a different ensemble each day. The ensembles tested were the United States Army Aircrew chemical defense ensemble, the United Kingdom aircrew chemical defense ensemble, and the United States standard flight suit uniform. While subjects made statistically larger heading errors while wearing the U.S. chemical defense ensemble, no operationally significant differences in performance were seen. It also was concluded that a pilot's performance was not an indicator of heat stress.

82-10. **Cathode-ray-tube raster line selector with horizontal modulation capability.** September 1982. *(ADA120596)*

By John H. Hapgood and Clarence E. Rash.

A simple and inexpensive circuit which provides a method of selecting the number and position of active raster lines visible on a CRT display is presented. Requiring inputs of vertical drive and horizontal and vertical sync signals, the circuit produces an output which can be fed directly into the video input of the display.

Fiscal Year 1983

83- 1. **Modified faceplate for AN/PVS-5 night vision goggles.** October 1982. *(ADA121151)*

By William E. McLean.

Lack of peripheral vision while flying with the AN/PVS-5 night vision goggles (NVG) was a contributing factor in an aircraft accident. Because of this accident,

a modified faceplate (MFP) for NVG was configured to allow pilots unaided lateral and lower vision. Twenty MFP NVG were worn during flight by 47 NVG-qualified aviators for an average of 18 hours per aviator. The average recorded flight hours for each of the 20 MFP NVG was 43.5 hours.

NVG aviators indicated that the MFP significantly enhanced intruder aircraft detection, inside-the-cockpit vision, and comfort. Spectacles can be worn with the MFP, and less fogging of the eyepieces occur. There were deficiencies reported during the study which were corrected with modifications to the mounting apparatus, through preflight briefings, and required familiarization flights.

The proposed modification is being considered for adoption by the proper authorities.

83- 2. **Threshold shifts and cochlear injury in chinchilla exposed to octave bands of noise centered at 63 and 100 Hz for 9 days.** October 1982. *(ADA121763)*

By Charles K. Burdick, James H. Patterson, Jr., Ben T. Mozo, C.E. Hargett, Jr., Roger P. Hamernik, and Donald Henderson.

The use of A-weighted sound pressure levels in hearing conservation criteria is based on scant data from low frequency exposures. This study contributes additional data from exposure to low frequency noise and attempts to relate it to damage risk criteria. Audiograms were obtained on 16 binaural chinchillas using a shuttle box avoidance procedure. The chinchillas then were exposed in groups to one of the following noise conditions for 9 days. Eight animals were exposed to an octave band noise centered at 1000 Hz: Four were exposed at an intensity level of 85 dB SPL (85 dBA) and four at an intensity level of 95 dB SPL (95 dBA). The 85-dB exposure produced a temporary threshold shift of 46 dB at 1.4 kHz with no permanent threshold shift. The 95-dB exposure produced a compound threshold shift of 60 dB at 1.4 kHz and a peak permanent threshold shift of 28 dB at 2.0 kHz.

The eight remaining animals were exposed to an octave band noise centered at 63 Hz: Four were exposed to an intensity level of 110 dB SPL (84 dBA) and four at an intensity level of 120 dBA SPL (94 dBA). The 110-dB exposure produced a compound threshold shift of 23 dB at 2.0 kHz with a peak permanent threshold shift of 7 dB at 2.0 kHz. The 120-dB exposure produced a compound threshold shift of 45 dB at 2.0 kHz and a peak permanent threshold shift of 19 dB at 2.0 kHz. The results of surface preparation histology produced mixed findings with cases of no permanent threshold shift and no hair cell loss, hair cell loss and no permanent threshold shift, and permanent threshold shift with hair cell loss that did not tonotopically correspond to the lesions. The findings are inconsistent with earlier data but consistent with A-weighted level providing an adequate predictor of noise induced hearing loss.

83- 3. **Hearing loss from low frequency noise.** (Reprint), October 1982. *(ADA121351)*

By Charles K. Burdick.

The auditory damage risk criteria (DRC) defining exposure to continuous noises specifies the intensity levels of noise in terms of A-weighted levels. A series of studies were undertaken to investigate the suitability of using A-weighted intensity levels in formulating the DRC. Groups of chinchillas were exposed to octave bands of noise with center frequencies of 31.5-, 63-, 125-, 250-, and 1000-Hz. Bands of noise with center frequencies below 500 Hz produced maximum threshold shifts three to seven octaves above the center frequency of the noise band. This sharply contrasts with the findings that bands of noise with center frequencies of 500 Hz and higher, produce maximum shifts of one to one and one-half octaves above the center frequency of the noise band. The general finding was that low frequency noise produces high-frequency hearing loss.

83- 4. **Physiological impact of wearing aircrew chemical defense protective ensembles while flying the UH-1H in hot weather.** October 1982. *(ADA121581)*

By Francis S. Knox, III, Gerald A. Nagel, Bruce E. Hamilton, Raul P. Olazabal, and Kent A. Kimball.

Six recent graduates of initial entry rotary-wing training flew a UH-1H for up to 4 hours while wearing each of three clothing ensembles. Each aviator wore the standard flight suit, the U.S. chemical defense (CD) ensemble, and the United Kingdom CD ensemble in hot weather (mean WBGT 29 C). Skin temperatures (chest, thigh, upper arm, and calf), rectal temperature, heart rate, and preflight and postflight body weights were recorded. Three of the six aviators terminated flight for medical reasons (heart rates > 140 bpm or nausea) while wearing the U.S. ensemble.

Well acclimatized aviators in this study who did not preflight and drank water every hour were able to fly for at least 2 hours (one fuel load) before the most susceptible subjects had to terminate flight due to heat stress. Heart rate was the most sensitive indicator of this stress. In this study, these susceptible subjects tended to be older and heavier. Although no measures of cardiopulmonary fitness (e.g., VO max) were made, it may be that these susceptible subjects were somewhat less fit. The U.S. ensemble was somewhat more stressful than the UK or standard ensembles.

Subjectively all subjects preferred the AR5 respirator to the M24 mask, were divided on overgarment vs. undergarment, and most disliked the U.S. overboots. As a caveat, it should be stated that fitness alone is not likely to be sufficient to over-

come the heat stress induced by these ensembles as flight times are extended. Some sort of cooling probably will be needed.

83- 5. **Analysis of image smear in CRT displays due to scan rate and phosphor persistence.** October 1982. *(ADA221095)*

By Clarence E. Rash and Jacob Becher.

The increase in the use of cathode-ray-tube (CRT) displays for target detection and recognition has placed an emphasis on the ability of these displays to accurately reproduce amplitude and phase information for dynamic targets. This analysis investigates the theoretical dynamic image degradation occurring at the display as a result of the interaction between the target/sensor relative velocity, the CRT system scan rate, and the persistence of the display phosphor. Expressions are developed to allow comparison of phosphors on the basis of modulation loss due to target/sensor motion. A model is developed which equates a target having a spatial frequency (S) and moving with a horizontal speed (V) to a stationary target with a sinusoidal varying intensity of frequency, f_t, equal to SV. The model identifies phosphor persistence as a major contributor to amplitude modulation loss and predicts several image artifacts such as "freezing" and apparent motion reversal.

83- 6. **Psychological effects of chemical defense ensemble imposed heat stress on Army aviators.** November 1982. *(ADA121956)*

By Bruce E. Hamilton, Ronald R. Simmons, and Kent A. Kimball.

Psychological testing was conducted with six Army aviators before and after flights in a UH-1H helicopter while wearing standard flight suits, U.S. or UK aircrew chemical defense ensembles. Additional testing on nonflight days was conducted to provide a baseline for evaluation. Tests consisted of encode/decode problems, math problems, logical reasoning problems, target detection problems, and a four-choice reaction time test.

Tests were scored for number attempted, percent correct, reaction time of correct and incorrect responses. Self reports of mood were also taken and scored. The results of the study indicated that various levels of ensemble-imposed heat stress caused orderly changes in psychological function and extended the results of laboratory investigations to the aviation setting. In addition, reaction time data showed changes in the pilot's ability to deal with "error" situations as a function of imposed heat stress and that self reports of mood were unreliable indicators of severe heat stress.

83- 7. **Psychological measurements during the wear of the U.S. aircrew chemical defense ensemble.** February 1983. *(ADA125616)*

By Bruce E. Hamilton and Liliana Zapata.

The psychological (as opposed to physiological) effects of wearing a U.S. aircrew chemical defense ensemble were evaluated using 12 male and 12 female volunteers. Half of the males and half of the females wore chemical defense ensembles while the rest wore standard U.S. flight suits as controls. All subjects were administered tests of cognition (math, logical reasoning, target detection, and reaction time) before and after 6 hours of wear in a controlled environment. In addition, subjects rated their mood before and after wear. It was concluded that wearing the ensemble in an undemanding environment degraded affect (mood and activation levels), slightly decreased accuracy, and substantially decreased reaction times, especially the females. The most serious impact of the ensemble would seem to be a decrease in morale among females.

83- 8. **Temporary threshold shifts produced by exposure to low-frequency noises.** (Reprint,) May 1983. *(ADA163266)*

By John H. Mills, J. David Osguthorpe, C. K. Burdick, J. H. Patterson, Jr., and Ben T. Mozo.

Groups of human subjects were exposed for 8 or 24 hours to an octave-band noise centered at 63, 125, or 250 Hz. For a 24-hour exposure at 84 dBA, temporary threshold shifts (TTS) increased for 8-12 hours and then either decreased or remained constant. Although TTS was less than 20 dB, complete recovery for many of the subjects required as long as 48 hours. Accordingly, the higher level exposure which was planned at 94 dBA for 24 hours was reduced to 90 dBA for 8 hours. For this condition, TTS increased throughout the 8-hour exposure. TTS from the 90 dBA noise for 8 hours exceeded the TTS produced by the 84 dBA; however, recovery from the 24-hour exposure required as long as 48 hours, whereas recovery from the 8-hour exposure required only 12-24 hours. Thus, the time for recovery is determined in part by the duration of exposure. TTS was not always maximal 1/2-1 octave above the band of noise, but was maximal in the frequency regions of better auditory sensitivity (350 to 750 Hz). For the 250 Hz condition, TTS increased about 1.5 dB per dB increase in noise level, whereas for the 63- and 125-Hz conditions TTS increased less than 1 dB per dB increase in noise level. More data are needed to specify the relation between TTS and the level of low-frequency noises.

83- 9. **Development of the swine as a large animal model for noise research.** May 1983. *(ADA129694)*

By Michael Ettinger, Dennis L. Curd, and James H. Patterson, Jr.

This report describes an attempt to develop the swine as a large animal model to be used in research on noise induced hearing loss. Animals were trained to perform in a "yes-no" signal detection paradigm for heat as a positive reinforcement. Results indicate that the animals can learn this task; however, the method failed to produce an audiogram. This was attributed to a failure to induce an adequate motivational level in the subjects.

83-10. **Impact and vibration testing of a modified UH-1 crew seat.** June 1983. *(ADA130279)*

By Dennis F. Shanahan, Joseph L. Haley, Jr., John C. Johnson, John H. Wells, and Heinrich Knoche.

The German air force has developed a modified UH-1 pilot seat designed to improve comfort by increasing support to the thigh and lower back, providing better vibration dampening and increasing cold weather comfort. This seat was tested for vibration dampening, pilot acceptance, and impact tolerance in a side-by-side test with the standard UH-1 seat. The modified seat is more comfortable than the standard UH-1 seat. The modified seat provides better impact protection than the standard seat, provided that the seat frame and restraint system do not tear loose. The modified seat does not provide better vibration dampening than the standard UH-1 seat.

83-11. **Attenuation variation obtained with subject fit of the Sigma Engineering triple-flange insert hearing protective device.** June 1983. *(ADA130676)*

By Jerod L. Goldstein.

The sound attenuation provided by a preformed triple-flange insert hearing protective device was determined when the user had no fitting instructions or training in the use of the device. This situation does occur in many instances among U.S. Army personnel. The results of this study indicate that the lack of training in the use of Sigma Engineering Triple-Flange earplug reduces the available sound attenuation provided by the earplug by approximately 5 dB at most frequencies. Furthermore, the attenuation was more variable than that found in the "experimenter fit" group of subjects tested. Adequate fitting instructions should be developed and issued with the hearing protectors. Users should be trained in the use of the device.

83-12. **Extent of hearing loss among Army aviators at Fort Rucker, Alabama.** August 1983. *(ADA132069)*

By Leslie J. Peters and Helen Ford.

This study provided hearing threshold data for Army aviators stationed at Fort Rucker, Alabama, from February through August 1982. The mean pure tone thresholds were found to be improved when compared to data gathered by Walden and McCurdy in 1971. This improvement partially was attributed to redesign of the aviation helmet and increased awareness and compliance with hearing conservation measures. It is possible that tighter administrative controls also contributed to the reduced threshold values. This study further indicated that, for Fort Rucker aviators, there exist three threshold regions correlated with flight hours: 50-400 flight hours, 401-3000 flight hours, and 3001-6000 flight hours. Each region has a specific range of hearing loss measured by comparing 2000 and 4000 Hz thresholds for the left ear. Anyone falling outside the threshold range for her/his respective region could be identified for possible follow-up procedures.

83-13. **Helicopter in-flight monitoring system---second generation (HIMS II).** August 1983. *(ADA132498)*

By Heber D. Jones, J. Alan Lewis, and Alford A. Higdon, Jr.

Presented is a description of a computerized airborne data acquisition system used to measure pilot performance in a UH-1 helicopter. The unit can record approximately 20 aircraft parameters in addition to other experimental data. This report also can serve as an operator's manual for the system.

83-14. **Impact response of an energy absorbing earcup.** September 1983. *(ADA134828)*

By Dennis F. Shanahan and Albert I. King.

Twelve impact tests on instrumented human cadavers were performed at Wayne State University to compare the load attenuating capability of an energy absorbing earcup with that of the standard rigid earcup used in SPH-4 flight helmets. SPH-4 helmeted cadavers were dropped from heights varying from 1.17 to 2.03 meters so as to receive a direct impact to the right side of the earcups. Loads were measured at the impact surface and accelerations were measured through a triaxial accelerometer mounted to the cadaver's maxilla. Analysis of the data shows a significant decrease in both peak load and acceleration in the y axis for the energy absorbing earcup equipped helmets over those measured for the standard earcup equipped helmets.

Fiscal Year 1984

84- 1. **UH-60 shoulder harness lead-in strap failure analysis.** October 1983. *(ADA138014)*

By Ted A. Hundley.

Shoulder harness lead-in strap failures have occurred in several UH-60 Black Hawk helicopter accidents with crewmembers being injured as a result. An investigation into possible failure causes was conducted. The two most likely causes found were incorrect installation of the seat insert guide and an increase in stress in the lead-in strap caused by the radius of bend at the point where the strap passes through the seat back. Tests showed that incorrect installation of the seat insert guide caused a significant reduction in the failure load of the webbing. Tests also showed that a reduction in failure load occurred when the webbing was pulled over a radiused corner. The first problem was solved by removing and reinstalling the seat insert guides. The second problem can be dealt with by using a higher-strength lead-in strap.

84- 2. **Comparison of real-ear attenuation characteristics of the standard SPH-4 earcup and a prototype crushable earcup.** December 1983. *(ADA138042)*

By Ben T. Mozo and William R. Nelson.

The use of the SPH-4 aviator's helmet in the Army is to provide hearing protection, voice communications, and head protection against impact. Efforts have been made recently to improve impact protection in the region of the earcup. In 1977, USAARL contracted with Simula Incorporated to develop an earcup which would provide greater energy absorption on impact and still provide sound attenuation equivalent to the current standard earcup. A prototype has been submitted for evaluation of noise attenuation and comparison to the current standard earcup. The crushable earcup was found to provide greater hearing protection at most test frequencies.

84- 3. **Effects of extended use of AN/PVS-5 night vision goggles on helicopter pilots' performance.** January 1984. *(ADA138126)*

By Lewis W. Stone and Chester E. Duncan.

The effects of extended use of AN/PVS-5 night vision goggles (NVG) were investigated by observing 10 NVG helicopter instructor pilots during two 6-hour missions. Each mission consisted of three 2-hour flights during which pilot control inputs and aircraft status variables were recorded in flight. Questionnaires were

completed before the first mission and after the NVG mission. In order to examine for a carryover effect, subjects were flown in a crossover design in which half of the aviators flew NVG on the first mission, the other half on the second. Only the out of-ground-effect hover showed a statistically significant carryover effect; that is, subjects who flew naked eye before NVG demonstrated a greater absolute difference in hover flight performance variability than those who flew naked eye after NVG flight. In the traffic pattern (final approach segment), there was a statistically significant difference between the visual conditions only. The postflight questionnaire responses revealed a concern over what was described as a "lack of concentration" and a "decline of mental alertness." Some physiological stress reactions were reported. None of the three maneuvers analyzed revealed a significant effect on performance across flights.

84- 4. **Development of a method to determine the audiogram of the guinea pig for threshold shift studies.** January 1984. *(ADA139717)*

By Carlos Comperatore and James H. Patterson, Jr.

Studies of noise induced threshold shift in guinea pigs require a method to determine the audiogram which meets the following criteria: It must be reliable and permit the determination of threshold at 8 to 12 frequencies in a single session lasting less than 1 hour. A conditioned suppression procedure was adopted to meet these requirements. Three guinea pigs were trained and a series of audiograms determined on each. The audiograms were found to be reliable and in good agreement with published audiograms determined by other methods.

84- 5. **Effects of chemical protective and oxygen masks on attenuation and intelligibility when worn with the SPH-4 helmet.** March 1984. *(ADA143535)*

By Ben T. Mozo and Leslie J. Peters.

The utilization of protective equipment by today's soldier is essential to enhance and ensure his ability to perform on the battlefield. However, a given personal protective system may influence the performance of another. This investigation evaluated the effects of three chemical defense masks on speech intelligibility and real-ear attenuation characteristics of the SPH-4 aviator helmet. The effects of two oxygen masks on speech intelligibility also were investigated.

84- 6. **In-flight evaluation of two molecular sieve oxygen concentration systems in U.S. Army aircraft (JUH-1H, JU-21G).** March 1984. *(ADA140634)*

By William A. Chaffin, Jr., Bruce F. Hiott, and Francis S. Knox, III.

The logistical problems associated with using high pressure gaseous oxygen systems have encouraged the development of molecular sieve oxygen concentration systems for use aboard aircraft. This report summarizes the in-flight static performance characteristics of two such oxygen concentrators installed in a JU-21G fixed-wing, twin-engine turbopropeller aircraft and a JUH-1H turbine-powered helicopter.

Flight profiles consisting of five separate flights at altitudes of 1,524, 3,048, 4,572, 6,096, and 7,620 meters (5,000, 10,000, 15,000, 20,000, and 25,000 feet) were flown in the JU-21G and five separate flights at altitudes of 1,524, 3,048, and 4,572 meters were flown in the JUH-1H.

Oxygen concentration at flows of 15, 25, 35, and 70 liters per minutes were recorded at each altitude. These flows were chosen to represent normal breathing requirements for one- and two-man crews. In all cases, the concentrators met or exceeded the requirements of MIL-R-83178. The use of engine bleed air to drive the oxygen concentrators produced no noticeable effect on aircraft performance.

84- 7. **Development of a micropressor based audiometer for threshold shift studies.** March 1984. *(ADA142124)*

By Ben T. Mozo, James H. Patterson, Jr., Ron Marrow, William R. Nelson, Ilia M. Lomba Gautier, and Dennis L. Curd.

In order to permit the collection of data on hearing threshold shift resulting from firing Army weapons, a multichannel microprocessor-controlled audiometer was developed. The system features four synchronized channels for determining hearing thresholds by a fixed frequency, fix test-time Von Bekesy tracking method. Non-standard, noise excluding headsets were developed as part of the system. Biological calibration of the system was accomplished by comparison to a clinical audiometer and a validation test was completed to demonstrate system accuracy and reliability. The results indicate the system is as accurate as, and more reliable than, the clinical audiometer.

84- 8. **Energy absorbing earcup engineering feasibility evaluation.** July 1984. *(ADA144179)*

By Ted A. Hundley and Joseph L. Haley, Jr.

The concept of using the integral structure of a noise-attenuating earcup as a

"load-limiting" or energy-absorbing device is explored in this report. The standard earcup of the Army's SPH-4 flight helmet is a very rigid structure which requires a force of approximately 22,000 newtons to cause it to deform, a force level three times greater than the crushing strength of the skull. Fifteen different "crushable" earcups were constructed and evaluated for noise attenuation to determine their suitability for prototype construction. Three earcups were selected for the "crushability" evaluation. The corrugated aluminum earcup was selected as the best of the three evaluated. The aluminum earcup was modified to lower the cost and to increase the crushing depth to nearly 2 cm. The feasibility of producing a "crushable" earcup with similar noise attenuation characteristics to the existing Army SPH-4 earcup was demonstrated.

84- 9. **Automatic gain control circuit for video signals of scenes of varying illumination levels.** July 1984. *(ADA144198)*

By John H. Hapgood and Clarence E. Rash.

A type of automatic gain control circuit useful for enhancement of video signals of scenes of varying light illumination levels is described. A DC voltage developed from the peak-to-peak input signal controls the effective gain of a video amplifier in a nonstandard method using a step-function control voltage.

84-10. **Anthropometric cockpit compatibility assessment of U.S. Army aircraft for large and small personnel wearing a training, warm-weather clothing configuration.** July 1984. *(ADA145208)*

By Aaron W. Schopper and David O. Cote.

To assess physical aviator-cockpit reach compatibilities, eight small subjects 146.9 to 162.5 cm in stature and eight tall subjects 182.3 to 194.5 cm in stature were placed in the cockpits of all current U.S. Army helicopters (except AH-64) and fixed-wing aircraft. Subjects were dressed in the warm weather training uniform of U.S. Army aviators and were requested to operate all primary controls and instructor-pilot designated critical switches, knobs, etc., with the shoulder harness in the unlocked position. Helmeted head clearance also was evaluated.

Among several candidate measures of upper- and lower-body reach capabilities, total arm reach ("span"), and crotch height, respectively, were found to be the most efficient discriminators between those who could and those who could not perform all critical operational reaches. Sitting height was employed to assess helmeted head clearance. Substantial variation was encountered in the reach-related demands for different aircraft. Minimum total arm-reach requirements throughout the fleet ranged from 147 to 168 cm; minimum crotch-height requirements ranged from 69

to 78 cm. Three aircraft could not accommodate a sitting height above 102 cm. Very large personnel experienced difficulty in achieving full lateral cyclic and stick movement in several aircraft.

84-11. **Anthropometric cockpit compatibility assessment of U.S. Army aircraft for large and small personnel wearing a cold weather, armored vest, chemical defense protective clothing configuration.** July 1984. *(ADA145472)*

By David O. Cote and Aaron W. Schopper.

This sequel to an earlier report upon individuals wearing a warm weather uniform presents the results of an anthropometric cockpit compatibility evaluation conducted with individuals wearing a "worst-case" tactical clothing configuration; i.e., a combination of cold weather, armored vest, and chemical defense protective clothing. Subjects corresponding in stature to the uppermost and lowermost 5th percentiles of the Army male population were placed in the cockpits of all current U.S. Army helicopters (except AH-64) and fixed-wing aircraft, and requested to demonstrate critical operational reaches with the shoulder harness unlocked.

As in the previous report, a relatively wide range of upper- and lower-body reach requirements were encountered. With the exception of a very large requirement associated with the TH-55 helicopter, upper-body reach requirements, as measured by total arm reach ("span"), ranged from 147-173 cm. For crotch height, the measure of leg-reach capability found most efficient, the range was 69-78 cm. Four aircraft could not accommodate the individual with the tallest sitting height (102 cm).

New and more extensive levels of previously encountered problems were evidenced regarding the ability of subjects to achieve full range of cyclic, stick, and yoke travel. Restraint harness and lap belt difficulties were also observed.

84-12. **The effect of modified spectacles on the field-of-view of the helmet display unit of the integrated helmet and display sighting system.** September 1984. *(ADA148693)*

By William E. McLean and Clarence E. Rash.

A study was conducted to establish the effect of wearing modified aviator spectacles, either for laser protection or refractive error correction, on the field- of-view available with the Helmet Display Unit of the Integrated Helmet and Display Sighting System. The determining factors of the available field were found to be helmet fit, eye fixation direction, and eye relief distance. The study concluded that when

these factors are optimized, the wearing of the modified spectacles does not result in a loss of field-of-view.

Fiscal Year 1985

85- 1. **SPH-4 U.S. Army flight helmet performance 1972-1983.** November 1984. *(ADA148674)*

By Thomas E. Reading, Joseph L. Haley, Jr., Arthur C. Sippo, Joseph R. Licina, and Aaron W. Schopper.

Injury data was obtained from the U.S. Army Safety Center for the occupants of U.S. Army aircraft who were both wearing aviator helmets and involved in duty-related aircraft accidents from the period beginning on 1 January 1972 and ending on 31 December 1982. The injury data was correlated with the physical condition of the helmets involved which had been obtained by the U.S. Army Aeromedical Research Laboratory under the Aviation Life Support Equipment Retrieval Program. The helmet performance was evaluated for future helmet designs. For consistency, only the 208 SPH-4s in the database were fully analyzed. An appendix contains a limited analysis of the APH-5s performance. It should be emphasized that no combat damaged helmets are discussed or analyzed in this report, i.e., no shrapnel or bullet damage is covered.

85- 2. **Effects of XM-40 chemical protective mask on real-ear attenuation and speech intelligibility characteristics of the SPH-4 aviator helmet.** February 1985. *(ADA153848)*

By William R. Nelson and Ben T. Mozo.

Chemical defense (CD) measures depend primarily on the use of protective clothing and equipment. Adequate protection only can be achieved if each item in the CD ensemble is compatible with every other item. The design or modification of each component must give consideration to its impact on the performance of all items. This study investigated the effects of the XM-40 Chemical Protective (CP) Mask on the protective functions of the SPH-4 aviator helmet. Based on the results it was concluded that the XM-40 compromised the noise attenuation and speech communication functions of the SPH-4.

85- 3. **The effect of impulse intensity and the number of impulses on hearing and cochlear pathology in the chinchilla.** June 1985. *(ADA161230)*

By James H. Patterson, Jr., Ilia M. Lomba Gautier, Dennis L. Curd, Roger P. Hamernik, Richard J. Salvi, C. E. Hargett, Jr., and George Turrentine.

Forty-one chinchillas, divided into seven groups, were exposed to 1, 10, or 100 noise impulses having peak intensities of 131 dB, 135 dB, 139 dB, or 147 dB. Hearing thresholds were measured in each animal prior to exposure using an avoidance conditioning procedure. Threshold shifts were monitored at regular intervals over a 30-day postexposure period. A surface preparation of the cochlear sensory epithelia was performed approximately 90 days after exposure. There was generally an orderly relation between the amount of permanent threshold shift and the severity of exposure, and a general agreement between averaged histological data and the audiometric data. Detailed relations between temporary and permanent threshold shift, cochlear pathology, and exposure variables are discussed, as are the implications of these data to the development of exposure criteria. All tabulated individual animal data, averaged group data, and individual cochleograms are presented in Appendixes A through D.

85- 4. **Helicopter-referenced single control, center-position force exertion capabilities of males and females.** August 1985. *(ADA161234)*

By Aaron W. Schopper and George R. Mastroianni.

In response to the need for reevaluation of anthropometric criteria contained in the U.S. Army medical standards for flying duty, an assessment was made of helicopter-control-referenced force exertion capabilities of a sample of Army males and females. Males (N=74) ranged from 159 cm through 196 cm in stature; females (N=66) ranged from 152 cm through 183 cm. The force-exertion data were compared to values cited in MIL-H-8501A as upper force limits for the design of helicopter controls. The focuses of the analyses were upon the force exertion capabilities of individuals 167 cm (65.7 inches) and below in stature since, by virtue of their relatively small size, they represent the portion of the population which are most apt to evidence inabilities to exert forces which equal or exceed control force design limits.

The comparison revealed that, overall, the presently existing limits (published in 1961) for other-than-the normal operational flight envelope exceeded the force exertion capabilities of 10 percent of the 39 small males evaluated and 27 percent of the 56 females evaluated. Most failures to achieve existing or proposed control force design limits occurred because of inabilities to attain criterion-level exertions in the downward direction on the collective. Predicated upon the force exertion data from the small individuals of this study, various combinations of specific control

force design limits were evaluated to develop estimations of overall "set-wise" failure rates likely to be encountered during possible future strength testing/screening. Because testing entailed no incentive for participation and involved multiple exertions within the session, it is anticipated that the percentage of failures encountered represent an overestimation of the failure-rate which would likely be encountered in the future while testing the strength capability of short individuals actually seeking to become or remain as aviators.

85- 5. **Dynamics of head protection (impact protection comparison of the SPH-4 flight helmet to a commercial motorcycle helmet).** July 1985. *(ADA161164)*

By R. Fred Rolsten and Joseph L. Haley, Jr.

The impact protection provided by a commercial motorcycle helmet is evaluated in this report. The motorcycle helmet utilizes an expanded plastic foam liner of 12 mm thickness, which is less than that used in most motorcycle helmets made in this country today. The thickness of the foam is identical to that used in the U.S. Army aviator's standard Sound Protective Helmet No. 4 (SPH-4). The impact protection provided by the commercial helmet is compared to the protection provided by the SPH-4 aviator helmet. A total of 16 metal headform impacts (8 for each of two helmets) were conducted using impact velocities ranging from 4.2 to 6.9 meters per second. By measuring the reaction force of the helmeted-headform impacts as well as the deceleration of the headform, we concluded that the helmets permitted transmission of injurious forces at all levels of energy beyond 4.5 mps contact velocity. The importance of increasing the thickness of the plastic foam liner in experimental SPH-4 helmets in order to reduce the deceleration force measured in the head-form is demonstrated. Evaluations of this nature provide the necessary database for developing helmet impact test standards as well as an awareness of the good and bad features of crash helmet design, regardless of the helmet type or the origin of manufacture.

85- 6. **Contrast sensitivity determined with the spatial bandwidth equalization technique: Threshold, supratheshold, and spatiotemporal measurements.** (Reprint), September 1985. *(ADA161218)*

By Roger W. Wiley, Thomas H. Harding, Michael G. Gribler, and Albert W. Kirby.

Contrast sensitivity functions were obtained from normal subjects using a spatial bandwidth equalization (SBE) technique and the more conventional display method. Static sensitivity measurements obtained with the two methods were in good agreement. However, when the patterns were counterphase flickered, sensitivity to the lower spatial frequencies sensitivity measured with the SBE technique was slightly

depressed. The SBE method also was used to investigate suprathreshold contrast perception with static and flickering gratings. In general, the perception of contrast was independent of spatial frequency content of the stimulus, especially with increasing contrast levels and flicker frequencies. These studies have shown that the SBE technique is an acceptable method to assess static contrast sensitivity and suprathreshold contrast perception.

85- 7. **The effects of diisopropylfluorophosphate on spatial frequency responsibility in the cat visual system.** (Reprint), September 1985. *(ADA161162)*

By T. H. Harding, A. W. Kirby, and R. W. Wiley.

Visual-evoked responses to counterphased gratings were recorded from area 17 of cat visual cortex before and after diisopropylfluorophosphate (DFP) administration. DFP produced effects similar to those obtained following physostigmine sulfate administration, in that responses to low spatial frequencies were preferentially reduced. The time course of the effects was quite different for the two types of drugs, and for high doses of DFP responses to all spatial frequencies were approximately uniformly depressed or abolished.

85- 8. **A cholinergic sensitive channel in the cat visual system tuned to low spatial frequencies.** (Reprint), September 1985. *(ADA161163)*

By T. H. Harding, R. W. Wiley, and A. W. Kirby.

Visually evoked responses to counterphased gratings were recorded from the cat visual cortex before and after physostigmine administration. Physostigmine markedly reduced the responses to low spatial frequencies, but minimally affected the response to high frequencies. This effect is considered cholinergic since it could be reversed by atropine. These results support at least a two-channel model of spatial frequency responsivity.

85- 9. **Helicopter copilot workload during nap-of-the-earth flight.** (Reprint), September 1985. *(ADA161192)*

By David O. Cote, Gerald P. Krueger, and Ronald R. Simmons.

Two automatic navigation systems, a Doppler radar system and a projected map system, and a hand-held map were examined for their effects on copilot/navigator workload and performance. The automatic navigation systems reduced the number of navigation errors and the size of deviations from intended track. The Doppler system reduced the time devoted to navigating and the number of verbal navigation messages exchanged between the pilot and copilot. The projected map system re-

duced visual workload. However, with all three navigation systems, more than 80 percent of the copilots' time was spent on navigation tasks, less than 10 percent of their time was visual "free time" that could be used for other tasks, and greater than 20 percent of the aircrew's time was occupied with navigation communications.

85-10. **Aviator performance in week-long extended flight operations in a helicopter simulator.** (Reprint), September 1985. *(ADA161165)*

By Gerald P. Krueger, Richard N. Armstrong, and Ronald R. Cisco.

Psychological, physiological, and biochemical correlates of aviator crew performance, stress, and fatigue were measured in a week-long flight schedule in a helicopter simulator. Three two-man crews of rotary- wing aviators performed 14 hours of precision instrument flight on each of 4 successive days and 10 hours on the 5th day. Missions involved repetitions of 2-hour standardized day- and night-flight profiles that were occasionally interrupted by simulated emergencies. Aviator performance measures included meeting assigned airspeeds, altitudes, headings, turn rates, and navigation requirements. Pilots slept 4 hours each night. Baseline data were collected prior to, and recovery data after, the extended flight schedule. Pilots maintained simulator flight parameters to within acceptable tolerances of assigned headings, airspeeds, and altitudes, even into the morning of the fourth day of the schedule. However, cognitive and judgmental errors were made. Even though flight surgeons deemed them unsafe to fly by the 3rd night, pilots continued to fly well to the 5th day.

85-11. **Basilar skull fracture in U.S. Army aircraft accidents.** (Reprint), September 1985. *(ADA161233)*

By Dennis F. Shanahan.

Of the 222 flight helmets retrieved from Army aircraft accidents during 1971--79 under the Aviation Life Support Equipment Retrieval Program, 175 were SPH-4 helmets that were analyzed for physical damage and for the relationship of damage to injury sustained by the wearer. This analysis showed that lateral impacts resulted in a significantly higher rate of serious injury (AIS>4) than impacts to other regions (68 versus 46 percent, $p<(0.001)$. Lateral impacts yielded a higher rate of basilar skull fracture than impacts to other areas of the helmet (46 versus 18 percent, $p<(0.001)$. It is concluded that lack of energy-absorbing material in the lateral portions of the helmet causes the high rate of basilar skull fracture and the increased prevalence of severe injury associated with lateral impacts. The incorporation of an energy absorbing earcup design is recommended to reduce the high rate of severe injuries associated with lateral impacts.

85-12. **Spinal injury in a U.S. Army light observation helicopter.** (Reprint), September 1985. *(ADA161320)*

By Dennis F. Shanahan and George R. Mastroianni.

All accident reports involving U.S. Army OH-58 helicopters were analyzed to determine vertical and horizontal velocity change at impact and the relationship of this kinematic data to the production of spinal injury. This analysis determined that spinal injury is related primarily to vertical velocity change at impact and is relatively independent of horizontal velocity change. The dramatic increase in the rate of spinal injury occurring just above the design sink speed of the aircraft landing gear (3.7 m/s) suggests that the fuselage and seat provide little additional impact attenuation capability above that of the gear alone. It is concluded that if this aircraft were modified to provide protection to the occupants for impacts up to 9.1 m/s (30 ft/s), approximately 80 percent of all spinal injury incurred in survivable accidents could be substantially mitigated. The incorporation of energy absorbing seats is recommended.

85-13. **Helicopter pilot back pain: A preliminary study.** (Reprint), September 1985. *(ADA161231)*

By Dennis F. Shanahan and Thomas E. Reading.

Because of the high prevalence of back pain experienced by U.S. Army helicopter pilots, a study was conducted to ascertain the feasibility of reproducing these symptoms in the laboratory. A mock-up of a UH-1H seat and control configuration was mounted to a multiaxis vibration simulator (MAVS). Eleven subjects were tested on the apparatus for two 120-minute periods. During one period, the MAVS was programmed to reproduce vibrations recorded from a UH-1H in cruise flight. The subjects received no vibration during the other test period. All subjects reported back pain which they described as identical to the pain they experience during flight, during one or more of their test periods. There was no statistical difference between the vibration and nonvibration test conditions ($p > 0.05$) in terms of time of onset of pain or intensity of pain as measured by a visual analog scale. It appears the vibration at the frequencies and amplitudes tested plays little or no role in the etiology of the back symptoms reported by these pilots. It is proposed that the primary etiological factor for these symptoms is the poor posture pilots are obliged to assume for extended periods while operating helicopters.

85-14. **Direct determination of the adequacy of hearing protective devices for use with the M198, 155mm towed howitzer.** September 1985. *(ADA162526)*

By James H. Patterson, Jr., Ben T. Mozo, Ron H. Marrow, R. W. McConnell, Jr., Ilia Lomba Gautier, Dennis L. Curd, Yancy Y. Phillips, and Robert Henderson.

The peak sound pressure levels of the M198, 155mm howitzer firing the M203 propelling charge are far in excess of the exposure limits set forth in the Army hearing conservation criteria. The levels are of a sufficient magnitude that there is serious question whether adequate hearing protection is available. This study provides direct evidence for the adequacy of the E-A-R earplug to protect against the impulse noise of the M198/M203. Fifty-nine volunteers were exposed to a progression of impulse noise levels produced by the M198 and tested for temporary threshold shift. It was found that the threshold shift exhibited by 95 percent of the volunteers was within acceptable limits after exposure to 12 rounds of M203 charge. This finding is interpreted to mean that these earplugs provide adequate hearing protection. In addition, volunteers were evaluated for evidence of laryngeal injury and intestinal injury. None was found.

Fiscal Year 1986

86- 1. **A chinchilla restraint system.** January 1986. *(ADA167408)*

By C. E. Hargett, Jr., James H. Patterson, Jr., Dennis L. Curd, Melvin Carrier, Jr., Ilia M. Lomba Gautier, and Robert J. Jones.

A restraint system is described that uses the chinchilla's natural behavior to accomplish positive positioning relative to the sound source for the exposure of research subjects to high intensity impulse noise. Photographs of the system in use and detailed drawings for construction are included. Using this system, 108 chinchillas were exposed without mishap.

86- 2. **The effects of cycloplegia on the visual contrast sensitivity function.** February 1986. *(ADA167407)*

By William G. Bachman and Isaac Behar.

Contrast sensitivity assessment is one of several emergent techniques being considered for inclusion in a visual standards battery for the Army, particularly for the evaluation of Army aviators. Since a cycloplegic refraction is required for initial selection of candidates for Class I and Class IA flying duty, it is important to determine what effect, if any, cycloplegia has on the contrast sensitivity function. Twelve

subjects, officers in preparation for flight training, who had passed a recent Class I flight physical, were tested. Contrast sensitivity functions were obtained under normal ambient conditions and in the presence of a glare source, both under manifest and cycloplegic conditions. Cycloplegia produced a small reduction in contrast sensitivity under normal ambient conditions, and a greater reduction under glare conditions. For both conditions, the cycloplegia effect was greater for the higher spatial frequency gratings than for the lower.

86- 3. **A comparison of speech intelligibility characteristics for earcups intended for use in the SPH-4 helmet.** March 1986. *(ADA167406)*

By William R. Nelson and Ben T. Mozo.

Studies at USAARL have demonstrated significant problems with impact protection in the area of the earcup of the SPH-4 aviator helmet. Efforts to develop a crushable earcup that will attenuate impact have resulted in development of two candidate earcups. This study compares the speech intelligibility characteristics of the two prototypes to those of the standard SPH-4 earcup and a proposed replacement earcup identified as the MK-1564. The results indicate that both crushable cups will provide speech intelligibility equal to or better than the standard cup.

86- 4. **The bushbaby optic nerve: Fiber count and fiber diameter spectrum.** March 1986. *(ADA221658)*

By Jim E. Fulbrook and Loretta Peterson.

The number, percent myelinated, density, and size distributions of optic nerve axons in the bushbaby "Galago crassicaudatus," were estimated from a partial areal survey of cross-sectioned tissue examined by electron microscopy. The average of the data obtained by two experimenters yielded a total fiber estimate of 384,500 (±19,200). Unmyelinated axons comprised 2.8 percent of the population. The fiber density between peripheral and central optic nerve samples was homogeneous and estimated to be 376 fibers per 1000um^2. Axon size distributions were distributed unimodally from 0.17-4.3 microns (mode=0.7). Unmyelinated axons ranged in size from 0.17 to 1.24 microns (mode 0=.41). The comparative implications of these results are discussed in view of the bushbaby as model for studies of human scotopic vision.

86- 5. **Concept proposal for an AN/PVS-5 simulator.** April 1986. *(ADA221203)*

By Jim E. Fulbrook, Bruce E. Leibrecht, and David J. Walsh.

An AN/PVS-5 simulator has been designed at USAARL to supplement night

vision goggle (NVG) training for ground units. This report discusses the specifications, characteristics, applications, benefits, and costs of the AN/PVS-5 simulator prototype.

The AN/PVS-5 simulator is a low-cost item consisting of the standard faceplate (without electrical components) and cushion with a sheet metal and filter insert that does not use batteries, which are the highest life cycle costs for NVG operations. The NVG is simple and easy to use, and durable with little or no maintenance requirements. It is designed for daytime training--indoors or outside as long as the ambient light is at a photopic level. The device effectively simulates most NVG conditions to include a 40 degree field-of-view, reduced acuity, loss of peripheral vision, loss of color cues, added out-of-balance weight, closed-in feeling around the face, etc. The AN/PVS-5 simulator is employable in most operational and environmental situations and is at least as safe to train with as actual NVGs.

Fielding a NVG training simulator would reduce wear and tear, and increase the longevity of actual NVGs. Supplementing training with the simulator would offer substantial cost savings by reducing the consumption of batteries used to power the actual NVGs. The NVG simulator has additional pragmatic advantages over the actual NVGs by its durability and widespread mission or training applications. The AN/PVS-5 simulator would supplement training equipment needs for units receiving fewer NVGs due to their basis of issue to procurement and budgetary restrictions.

86- 6. **Concept study of closed-loop medical expert systems.** April 1986. *(ADB128601L)*

By Douglas E. Landon.

A concept study was conducted to investigate the design of closed-loop medical expert systems. Medical expert systems are computer programs incorporating artificial intelligence techniques that attempt to imitate the expertise of, or aid physicians. A closed-loop medical expert system would be designed to both aid physicians and also perform some diagnostic and treatment functions autonomously with the help of electronically actuated biomedical sensing and treatment equipment. The concept study explored current techniques and issues in knowledge representation, inference, and management to derive a basic organizational and functional design for a closed-loop medical expert system in the field of emergency medicine. The study proposed that a hybrid system composed of several expert systems for sensing, diagnosing, treating, and managing that communicate through a blackboard may meet the diverse needs and activities of emergency medicine. The constituent expert systems would probably be frame-based.

86- 7. **The role of peak pressure in determining the auditory hazard of impulse noise.** April 1986. *(ADA202906)*

By James H. Patterson, Jr., Ilia M. Lomba Gautier, Dennis L. Curd, Roger P. Hamernik, Richard J. Salvi, C. E. Hargett, Jr., and George Turrentine.

Most current damage risk criteria (DRC) for human exposure to impulse noise are written in terms of peak pressure as the primary index of traumatic potential or hazard associated with exposure to an impulse noise. Since the peak pressure is only one of many parameters of an impulse, there is a question whether or not a DRC based on peak pressure can reflect accurately the hazard to hearing posed by impulse noise. The experiments described in the report were designed to determine whether peak pressure is an adequate quantifier for an impulse noise DRC.

The general approach was to construct two types of impulse noise with the same Fourier pressure spectrum, but with different peak pressures. This makes it possible to compare the hearing loss and injury resulting from impulses which have the same total energy distributed the same way across frequency, but with different peak pressures. We also can compare injury from different levels. A total of 36 animals were divided into six groups (six animals/group). Groups 1 and 2 were exposed to impulses having approximately equal energy, but with peak pressures that differed by 8 dB. Similarly, groups 3 and 4 and groups 5 and 6 formed pairs of exposed groups where the energy was equivalent, but the peak pressure differed by 8 dB.

Threshold shift was measured for 30 days postexposure and injury to the cochlea was determined by examination of surface preparations of the basilar membrane. The threshold shift measured during the first few hours after exposure showed systematic variation with both peak pressure and energy level. The permanent threshold shift (20 to 30 days postexposure) and the loss of sensory cells showed strong dependence on energy level with a less pronounced dependence on peak pressure. These results indicate that peak pressure is not a sufficient indicator of auditory hazard; however, energy alone is not a sufficient indicator either.

86- 8. **A comparison between the speech intelligibility characteristics of the XM-43 and the M-24 protective masks.** April 1986. *(ADB128493L)*

By William R. Nelson and Ben T. Mozo.

The development of protective masks for use in the aviation environment can have significant impact on the ability of the aviator to communicate orally. Recent studies at USAARL have demonstrated significant speech communication problems between the SPH-4 aviator helmet and a variety of masks. This study investigated the effects of the XM-43 mask on the speech communication functions of the SPH-4 helmet. The XM-43 did not degrade communications for either talker or listener.

The current standard mask, the M-24, was used for comparison. The XM-43 was better than the M-24 for communication purposes.

86- 9. **Seated eye positions and anthropometric extremes of aviators.** May 1986. *(ADA191656)*

By David O. Cote and Aaron W. Schopper.

Seated eye positions of personnel in the 1st to 5th percentile range and the 95th to 99th percentile range for male stature were examined in six U.S. Army helicopters to determine if their seated eye positions were significantly different from those of instructor pilots. In addition, the zero azimuth, outside-the-cockpit field-of-view of anthropometrically extreme personnel and instructor pilots was measured. Large differences in viewing angles were also observed in all aircraft. However, in the case of personnel in the 1st to 5th percentile range for male stature, the differences were to their advantage. In the case of personnel in the 95th to 99th percentile for male stature, field-of-view was considerably decreased in some aircraft. Further study is needed to determine what effects the reduced field-of-view for tall personnel may have on flying performance.

86-10. **In-flight control force inputs for the U.S. Army UH-1 helicopter during "hydraulics-on" and "hydraulics-off" approaches and landings.** May 1986. *(ADA191657)*

By Aaron W. Schopper, John H. Wells, and Leon R. Kaylor.

There is little information available regarding the magnitude of force input to helicopter controls under emergency conditions. Accordingly, 12 male U.S. Army aviators each flew six normal and six simulated emergency condition ("hydraulics-off") approaches and landings in an Army JUH-1 utility helicopter. Because there existed concern that forces applied might vary substantially with flight experience, the aviators who participated in the study were solicited from two groups differing widely in the number of hours flown. The six less-experienced aviators had between 170 and 200 hours of flight time (mean = 183), and the six more-experienced aviators had between 1300 and 2750 hours of flight time (mean = 2250). The three principal controls of the aircraft (cyclic, collective, and pedals) were strain-gage instrumented. The outputs recorded during the last 60 seconds of flight prior to each touchdown were studied. Analyses of variance undertaken on the means of forces recorded during successive 5-second intervals revealed significant differences in the magnitude of the forces applied as a function of hydraulics condition and time-to-touchdown; i.e., forces differentially increased as touchdown neared during hydraulics-off approaches.

Significant interactions involving level-of-experience were discovered; the nature

of the effects differed among the various controls and directions-of-input. With the exception of inputs in the downward direction on the collective, the descriptive statistics showed the overall mean and median forces for both groups of aviators to be lower than previously reported helicopter-control-referenced maximal 4-second strength capabilities of small Army males and females.

86-11. **Improved design criteria for crash helmets.** May 1986. *(ADA192017)*

By R. Fred Rolsten and Joseph L. Haley, Jr.

A commercial motorcycle helmet was impact evaluated. The motorcycle helmet's impact protection is compared to that of the SPH-4, the standard Army aviator's helmet. Drop tests, ranging from 0.91- to 2.44-meters, were used for the helmet testing by means of a helmet/headform free-fall device. The two examples of the helmet were subjected to 16 drop tests. Two of these drop tests resulted in a high level of transmitted force and acceleration which focuses on the inadequate protection to prevent concussion or serious injury at all energy levels greater than produced at a 1-meter drop height. The tested helmets could be changed to provide adequate protection by doubling the thickness of the liner.

86-12. **Microclimate cooling and the aircrew chemical defense ensemble.** May 1986. *(ADB123948L)*

By Glenn W. Mitchell, Francis Knox, III, Ronald Edwards, Robert Schrimsher, George Siering, Lewis Stone, and Philip Taylor.

The psychological, physiological, and operational effects of sustained aviation operations in the standard U.S. Army chemical defense ensemble were studied in six male aviators during continuous 6-day sessions in a hot, humid field environment. Standard aviation mission durations and profiles were flown in a specially-equipped JUH-1H helicopter while wearing level IV mission-oriented protective posture (MOPP IV) garments. A single case design was used to investigate the effects of microclimate cooling devices of both air and liquid medium design. Results show that cooling is not physiologically necessary below cockpit temperatures of 29° C WBGT although subjective benefit was reported.

Above 29° C WBGT cockpit temperature with closed aircraft windows and doors, microclimate cooling was necessary to avoid adverse effects of body core temperature increases. No physiologic differences were observed during use of any of the cooling devices tested. Mood and throughput changes were noted during twice-daily psychological testing. No operationally significant performance decrements were noted during the study due to physiologic effects, although several flights were terminated due to equipment-related medical problems. Daily serum electrolyte determinations and 24-hour urine collections revealed no significant abnor-

malities. Total water consumption was below estimates based on previous studies and indicates a need for reassessment of water intake policy for other than desert environments.

86-13. **Smoking and soldier performance: A literature review.** June 1986. *(ADA221504)*

By Frederick N. Dyer.

Research was reviewed on smoking as it relates to soldier performance for the U.S. Army Medical Research and Development Command. This literature review resulted from an unsolicited proposal submitted by Research Solutions, Incorporated, in response to the Board Agency Announcement of the Command. Research on smoking and other nicotine effects was included in the review. The research reviewed was related to position disclosure in combat; the effects of smoking on physical work capacity and endurance; the effects of smoking on perceptual processes; the effects of smoking on arousal and ability to deal with stress, pain, and fear; smoking- induced hormonal changes; the effects of tobacco deprivation; smoking-disease relationships and their effects on productivity and absenteeism; smoking and abuse of other substances, delinquency, and accidents; and associations between smoking and other factors of potential relevance to soldier performance.

Among the main findings, the review disclosed detrimental effects of smoking on physical performance of soldiers, particularly soldiers with several years of tobacco exposure. The review also identified nicotine-related improved performance on vigilance and rapid information processing tasks, including tasks that may be relevant to some soldier tasks. It also showed a constellation of negative behaviors that are correlated with smoking such as drug abuse, delinquency, and driving accidents. Research in many areas critical to soldier performance, such as the effects of smoking on dark adaptation and the effects of smoking on testosterone production, showed contradictory results that need additional research for resolution. Needs for additional research on smoking and soldier performance were included as a final chapter of this report.

86-14. **Proportions of overall U.S. Army male and female populations eligible for flying duty: Impact of linear anthropometric screening requirements.** August 1986. *(ADB128602L)*

By Aaron W. Schopper.

To ascertain the impact on U.S. Army male and female population bases, the dimensions cited in two previously reported studies on the anthropometric arm-reach, leg-reach, and sitting height cockpit compatibility-related constraints

inherent in each existing U.S. Army fixed-wing and rotary-wing aircraft (except the AH-64 Apache) were transformed into percentile equivalents. The percentage of the male and female populations excluded on each dimension was cited for each aircraft.

Additionally, the percent of exclusion was calculated for each aircraft based upon the simultaneous conjoint consideration of all three measures to determine the anticipated percent-of-exclusion which would result when applicants were actually evaluated during flight physicals (wherein a failure to meet the standard on any single dimension would have the same impact as failing to meet all three). The data which resulted were considered vis-a-vis such factors as aircraft-specific aviator demand, aircraft mission versus DA policy on utilization of females in combat roles, warm-weather training versus cold-weather/armor plate/chemical defense clothing configurations, physical strength-related issues, extent of heterogeneity in the reach-related demands encountered among the various types of aircraft evaluated, and single-criteria versus aircraft-specific criteria.

The recommendations proposed a single set of linear anthropometric initial entry screening criteria which were compatible with the training helicopter (TH-55), the Army's utility helicopters (UH-1 and UH-60), and two of the Army's fixed-wing aircraft (C-12 and OV-1). Collectively, these initial-entry screen criteria were compatible with 60 percent of the Army's rotary-wing aircraft and 55 percent of the Army's fixed-wing aircraft. Aircraft-specific linear anthropometric screening criteria were recommended for the remaining rotary-wing (AH-1, CH-47, OH-6, and OH-58) and fixed-wing (T-42, U-8, and U-21) aircraft.

86-15. **Some effects of anticholinesterase drugs and their antidotes on extraretinal photoreceptor cells of Aplysia californica.** September 1986. *(ADA174909)*

By James P. Apland.

Aplysia extraretinal photoreceptor (ERP) cells R2, LPl_1, and VPN were used as models of phototransduction. The early steps of light transduction in Aplysia ERP cells are very similar to those proposed in the calcium scheme for vertebrate rod outer segments. The effects of cholinesterase inhibitors and their antidotes on photoresponses in Aplysia were investigated by electrophysiological methods. Bath application of diisopropyl flourophosphate (DFP), a potent irreversible organophosphate-type cholinesterase inhibitor, consistently decreased the maximum amplitude of the photoresponse elicited by flashing a light on Aplysia ERP cells. DFP did not change membrane resistance, nor did it change the reversal potential for the photoresponse. Physostigmine, a reversible carbamate-type cholinesterase inhibitor, depressed both photoresponse amplitude and membrane resistance. Attenuation of photoresponse was dose-dependent with both DFP and physostigmine and was completely reversed by washing out the drugs. Physostigmine was less potent. Both drugs caused depolarization of the resting membrane potential (RMP). Pyridostigmine, another reversible carbamate-type cholinesterase inhibitor, had no effect on photoresponse or mem-

brane resistance at five times the concentration used for physostigmine. Bath application of carbachol, which would mimic a buildup of acetylcholine (ACh) following cholinesterase inhibition, caused a persistent hyperpolarization of RMP. Carbachol caused attenuation of both photoresponse and membrane resistance. Previous studies have shown that DFP inhibits Na, K-ATPase. Depolarization after treatment of ERP cells with 10^{-3}M ouabain, suggests that this depolarization is not caused by Na pump inhibition. The muscarinic ACh receptor antagonist atropine blocked the photoresponse attenuation caused by the DFP. Atropine did not block the attenuation of photoresponse and membrane resistance caused by physostigmine and carbachol. Calcium-free, high-magnesium sea water, which blocks release of ACh and other neurotransmitters, did not block the attenuation of photoresponse caused by DFP.

The effects of DFP are reversible, and different from those of physostigmine and carbachol. Calcium-free sea water did not block DFP's effects. These results suggest that the effects of DFP on ERP cells are not due simply to a buildup of ACh at synapses subsequent to cholinesterase inhibition. Atropine's block of DFP's effects might be caused by competition for binding sites.

Fiscal Year 1987

87- 1. **Head movements during contour flight.** October 1986. *(ADA181203)*

By Robert W. Verona, Clarence E. Rash, William R. Holt, and John K. Crosley.

This head movement study was conducted to measure pilot head rotational movements during contour flights. The head movement data were collected from five subjects as each flew a modified UH-1M over a 15-mile contour course. The subject pilots also were required to visually search for "enemy" aircraft while flying the contour course. A helmet-mounted sight was used to measure the pilots' head movements. The head position data indicate the pilots looked forward most of the time, even though the scenario required a broad range of head movements. The data also suggest pure head-neck movements without torso participation. The head velocity data indicate symmetrical azimuth and elevation head movement components. Approximately 97 percent of the head movements were equal to or less than 120 degrees/sec, although some movements exceeded 200 degrees/sec.

87- 2. **Controlling impulse noise hazards: Programmatic model for developing validated exposure standards.** (Reprint), November 1986. *(ADA181430)*

By Bruce C. Leibrecht and James H. Patterson, Jr.

Blast-producing weapons such as artillery cannons, mortars, and rockets can

produce serious hearing loss among combat troops. Effective control of the risks of hearing loss requires realistic, valid standards for noise hazard evaluation and materiel design. Unfortunately, current Army standards for impulse noise are neither founded on a thorough scientific database nor validated for operational scenarios. These limitations make it difficult to balance the requirement for improved weapons against the need to protect crewmembers' hearing. In support of the Army's Health Hazard Assessment Program, a multiphase research model has been developed to provide a scientific foundation for valid impulse noise standards. The model constitutes a blueprint of the programmatic building blocks required to achieve the ultimate goal of realistic, effective standards applicable to a broad spectrum of weapons. Laboratory and field research methods are used to establish a systematic, comprehensive database relating auditory injury to critical noise parameters. The model culminates in validation of new standards under realistic field conditions. Implementing the model requires long-term research commitments in executing the program. Once established, the new noise exposure standards can be translated into hearing conservation standards, materiel design standards, and noise hazard assessment procedures. These new weapons which are, at the same time, safer and more effective.

87- 3. **Low altitude, high speed personnel parachuting: Medical and physiological issues.** February 1987. *(ADA181199)*

By David J. Wehrly.

This report reviews the medical and physiological issues of high speed, low altitude parachuting. Accident and experimental data are reviewed. The dearth of experimental/operational data related to these issues is noted.

87- 4. **The combat emergency medicine expert system (CEMES) project phase I report.** March 1987. *(ADA181391)*

By Douglas E. Landon.

The exploratory development of an expert system (designated CEMES: Combat Emergency Medicine Expert System) designed to diagnose and treat hemorrhagic shock under battlefield conditions is being conducted. This report outlines the project's rationale and documents the major design concepts underlying the exploratory development of CEMES. The project is being conducted in two phases. The first phase has been completed, consisting of the design of a basic CEMES that can diagnose hemorrhagic shock and simulate fluid infusion treatments. This report summarizes the interim progress of this project at Phase I.

87- 5. **Results of physiological monitoring from the 1985 P^2NBC^2 Tests at Fort Benning, Georgia.** April 1987. *(ADB119560)*

By Glenn W. Mitchell, Francis S. Knox, III, and David J. Wehrly.

Physiological recordings from field tests of mechanized infantry personnel in chemical protective gear are presented. Limitations to performance are documented and discussed in the context of the overall "Physiological and Psychological Effects of NBC and Sustained Operations in Combat Crews (P^2NBC^2) Program." In the warm conditions found during this study, mechanized infantry squads were able to continue for 62 hours with hasty decon and meals and 32 hours without breaks in chemical protective gear without auxiliary cooling.

87- 6. **Results of physiological monitoring from the 1985 P^2NBC^2 tests at Fort Knox, Kentucky.** April 1987. *(ADB119559)*

By Francis S. Knox, III, Ronald Simmons, Roger Christiansen, and George Siering.

Physiological recordings from field tests of armor personnel in chemical protective gear are presented. Limitations to performance are documented and discussed in the context of the overall "Physiological and Psychological Effects of NBC and Sustained Operations in Combat Crews (P^2NBC^2) Program." In the hot conditions found during this study, tankers were able to continue for only an average of 6 hours in chemical protective gear without auxiliary cooling.

87- 7. **Measurement of gunner head acceleration during firing of high impulse guns on lightweight armored vehicles and the assessment of gunner tolerance to such impact.** July 1987. *(ADA191615)*

By Ted A. Hundley and Joseph L. Haley, Jr.

This report provides gunner head acceleration data from the live firing of 105 mm and 152 mm turret guns on the M-551 and M-60 tanks. The head accelerations were measured with a gunner volunteer and with an anthropomorphic dummy in stationary tanks. The head acceleration values ranged from 4 Gs in the heavy M-60 tank up to 14 Gs in the light M-551 tank. A comparison of these acceleration levels to the known human tolerance data indicates no problem for single exposures for most gunners, but it is possible that some gunners will experience headaches and neck strain. The effect of repeated exposures at the 14 G level is not known and further research is recommended.

87- 8. **Evaluation of the U.S. Army fitting program for the Integrated Helmet Unit of the Integrated Helmet and Display Sighting System.** July 1987. *(ADA191616)*

By Clarence E. Rash, John S. Martin, Daniel W. Gower, Jr., Joseph R. Licina, and John V. Barson.

The fitting program for the Integrated Helmet Unit for the AH-64 developed at the U.S. Army Aeromedical Research Laboratory is documented. Recommendations for the design of training and field unit fitting programs are outlined.

87- 9. **Direct determination of the adequacy of hearing protection for use with the Viper.** August 1987. *(ADA191652)*

By James H. Patterson, Jr. and Ben T. Mozo.

During developmental testing it was determined that the Viper antitank weapon produced impulse noise which exceeded the maximum levels permitted by MIL-STD-1474. In order to proceed with operational tests, it was necessary to determined whether adequate hearing protection could be provided. This study involved the exposure of 38 volunteers to two rounds of Viper fired in rapid succession while wearing EAR™ earplugs. The average exposure peak level was 181 dB SPL. Audiograms were taken before and after exposure. No detectable changes in hearing were observed in the group of volunteers. From this, it was concluded that EAR™ earplugs provide adequate protection for at least two rounds of Viper.

87-10. **A limited user evaluation of the Integrated Helmet and Display Sighting**
(USGO) **System.** August 1987. *(ADB119558L)*

By Clarence E. Rash and John S. Martin.

A questionnaire requesting user evaluation of the Integrated Helmet and Display Sighting System was distributed to AH-64 aviators in training units at Fort Rucker, Alabama, and field units at Fort Hood, Texas. The questionnaire addressed the areas of quality of system components, helmet fit and comfort, and system performance. Data from 133 aviators are presented and discussed.

87-11. **Compendium of U.S. Army visual medical fitness standards.** August 1987. *(ADA199583)*

By David J. Walsh and Richard R. Levine.

This report reviews vision standards pertaining to entry onto active duty, reten-

tion, and mobilization of officer and enlisted personnel in the U.S. Army. It also contains current vision requirements for each enlisted and warrant officer military occupational specialty (MOS) and commissioned officer specialty skill identifier (SSI). Also summarized are "special" vision standards with application either to all personnel, to a specific subgroup, or a select few. These include, as examples, particular vision requirements for flying duty, marine diving, military driver's licensing, special operations training and assignment, and admission to the U.S. Military Academy, Reserve Officer Training Corps, and Officer Candidate School. All standards are referenced to their appropriate governing published regulation. Confusion within and contradictions to existing regulatory requirements are discussed as appropriate.

87-12. **An operational evaluation of extended-wear soft contact lenses in an armored division.** August 1987. *(ADA191617)*

By William G. Bachman, Bruce C. Leibrecht, John K. Crosley, Dudley R. Price, Gerald Bentley, and Patrick Leas.

The purpose of this study was to evaluate the safety and military effectiveness of wearing contact lenses in an operational armor environment. Male volunteers from eight battalions of an armored division at Fort Hood wore extended-wear soft contact lenses (SCLs) or spectacles for up to 6 months. During this period, physiological and subjective measures were obtained, along with logistical and personnel support information. Three types of SCLs were worn: High, medium, and low water content lenses. Subjects followed their normal training schedule in garrison and on training ranges. Seventy-four percent of those successfully fitted with SCLs wore their lenses for the duration of the study, when administrative losses were factored out.

More than a third of the SCL wearers experienced one or more ocular conditions requiring at least a temporary suspension of lens wear. A large majority of contact lens wearers indicated the SCLs improved their vision and job performance. These results represent the beginning of a database intended to address a variety of operational settings, environmental factors and job demands.

87-13. **Dark adaptation and recovery from light adaptation: Smokers versus nonsmokers.** September 1987. *(ADA191654)*

By Roger W. Wiley.

Since the published data concerning the effects of smoking on visual sensitivity at night are inconsistent, a new study was initiated to investigate this question. Thirty Army aviators between the ages of 19 and 39 volunteered to participate in this study. Of the subjects, 15 smoked and 15 were nonsmokers. Each subject was seated in a light-controlled room and exposed to a standardized bright light for 5 minutes. Immediately after the bright light was extinguished, the subject's visual sensitivity was

tested by gradually increasing the intensity of a test light until the subject could see it. This was continued over a period of 35 minutes by which time the subjects had reached their maximum light sensitivity. Each subject then wore a pair of AN/PVS-5 Night Vision Goggles for 5 minutes after which his visual sensitivity again was tested for 20 minutes.

Our data do not show any differences in visual sensitivity between aviators who smoke and those who do not smoke. Blood samples were analyzed to compare serum levels of nicotine, cotinine and carboxyhemoglobin with the visual data. Again, no correlation exists between sensitivity and blood measures related to smoking. Aviators who smoke reach the same level of sensitivity to light as nonsmokers and they do so in the same amount of time. Visual recovery after wearing the night vision goggles also followed the same time course regardless of smoking history. The conclusion from these data is that light sensitivity, the ability to see the dimmest lights at night, is independent of smoking history.

87-14. **Simultaneous multiple control force exertion capabilities of males and females versus helicopter control force design limits.** September 1987. *(ADA191653)*

By Aaron W. Schopper and George R. Mastroianni.

Military standards and design guidelines do not consider the potential for degradation in the magnitude of force which can be applied by a crewmember or operator as the result of having to perform more than one control input at the same time. In assessing helicopter-control-referenced strength capabilities as a part of an overall program to update medical standards for U.S. Army flying duty, 130 subjects performed maximal voluntary exertions on each of the three primary helicopter controls (cyclic, collective, and pedals). These exertions were undertaken both as separate inputs to single controls and as simultaneously executed inputs to all three controls.

The findings revealed substantial and significant force degradation occurred during simultaneously executed exertions (relative to the magnitudes of single control exertions). Cyclic inputs were affected least. The degree of force degradation associated with collective and pedal inputs varied with the particular combinations of direction-of-exertion employed. The resulting "patterns" for force degradation were similar for the collective and pedal with the extent of degradation being larger for the pedal inputs (typically 40-50 percent) than for collective inputs (typically 20-35 percent). Substantial proportions of the subjects (approximately 50 percent of the males and more than 90 percent of the females) were unable to consistently attain design guide force levels (MIL-H-8501A, 1961) on all three controls during all of the 16 simultaneously executed exertions. There exists a need to consider simultaneously executed force inputs in relevant design guides and standards and the probability of an aviator being confronted with those input requirements.

Section B

Authors' index for technical reports.

= C =

= J =

= K =

= L =

= M =

= Mc =

= N =

= O =

= P =

Section C

Subject index for technical reports.

= A =

= B =

= C =

= D =

= E =

= **F** =

= M =

= N =

= R =

= S =

= T =

= U =

= V =

= W =

= X =

Section D

Listing of letter reports

by title and author(s).

The first 117 letter reports written by USAARL were not numbered initially upon publication. The first 11 also are undated. To facilitate easy referencing and location of originals, these first 117 letter reports have been assigned numbers. These numbers are shown in parentheses before the title. This numbering is used in cross referencing and in the indexes published by USAARL.

LR Number **Title**

(1). **Binocular neutrons in the dorsal lateral geniculate nucleus of the rabbit.**
Undated.
By Roger W. Wiley and David L. Stewart.

(2). **Effects of helicopter downwash.**
Undated.
By William P. Schane and Robert W. Bailey.

(3). **Escape system requirements for U.S. Army aircraft in Vietnam.**
Undated.
By Delvin E. Littell, Robert W. Bailey, and William P. Schane.

(4). **Evaluation of the human body as an airfoil.**
Undated.
By William P. Schane.

(5). **An evaluation of the toxic hazard from propellant actuated devices aboard armed helicopters.**
Undated.
By George L. Hody.

(6). **Military parachuting, subtask No. 1: Weight/height ratio and airborne training.**
Undated.
(Author unknown.)

(7). **Military parachuting, subtask No. 2: Photography of impact.**
Undated.
By Harold R. Chappell and John D. Lawson.

(8). **Newer techniques in phonocardiography.**
Undated.
By John D. Lawson and Richard L. Wall.

(9). **Trans-callosal projections to the rabbit's visual cortex.**
Undated.
By Roger W. Wiley, David L. Stewart, and Marilee P. Ogren.

(10). **Weight reduction.**
Undated.
By William P. Schane.

(11). **Device 2B24 operational suitability test: Results summary and comments.**
Undated.
By Paul W. Caro, Robert N. Isley, and Oran B. Jolley.

Fiscal Year 1964

(12). **Preliminary survey of acceleration and pilot disorientation problems in Army aircraft.**
March 1964.
By George C. Crampton, Jimmie L. Hatfield, J. C. Rothwell, W. C. Thrasher, and J. L. Shelby.

Fiscal Year 1965

(13). **Internal noise evaluation of the off-the-shelf fixed-wing instrument trainers and carbon monoxide investigation of the off-the-shelf fixed-wing instrument trainers.**
October 1964.
By William C. Thrasher.

(14). **Noise analysis of the CV-7A.**
October 1964.
By William C. Thrasher.

(15). **Aviation toxicology.**
December 1964.
By William C. Thrasher.

Fiscal Year 1966

(16). **Impulse noise sound pressure levels of the XM-23 lightweight protective fire subsystem.**
August 1965.
By Robert T. Camp, Jr.

(17). **Impulse noise sound pressure levels of the XM-24 lightweight protective fire subsystem.**
August 1965.
By Robert T. Camp, Jr.

(18). **Noise spectra of the YCH-54-A.**
October 1965.
By Robert T. Camp, Jr.

(19). **Impulse noise sound pressure levels of the XM-21 protective fire subsystem.**
December 1965.
By Robert T. Camp, Jr.

(20). **Impulse noise sound pressure levels in the armored version of the CH-47A transport helicopter.**
December 1965.
By Robert T. Camp, Jr.

(21). **Test of the ventilated flight suit.**
December 1965.
By Lloyd E. Spencer.

(22). **Height limitations for Army aviators.**
February 1966.
By William P. Schane.

(23). **Proposed standard: Recommendation for evaluating vibration exposure of humans.**
March 1966.
By William P. Schane.

(24). **Air contaminant measurements in the armed Chinook.**
April 1966.
By George L. Hody and Sidney Zimmet.

(25). **Sound pressure levels of noise in the CH-47A helicopter.**
June 1966.
By Robert T. Camp, Jr.

Fiscal Year 1967

(26). **Sound pressure levels in a standard UH-1B helicopter and a UH-1B equipped with the Model 540 rotor system.**
July 1966.
By Robert T. Camp, Jr.

(27). **Weapon exhaust accumulation on the tail ramp of a JCH-47A during firing of an XM-24 machine gun in flight.**
November 1966.
By William P. Schane.

(28). **LOH-6A (Hughes) lighting survey.**
January 1967.
By John K. Crosley.

(29). **Carbon monoxide measurement in the Enstrom F-28.**
February 1967.
By George L. Hody and Gerhard Y. Swidzinski.

(30). **Effects of helicopter downwash.**
February 1967.
By William P. Schane and Robert W. Bailey.

(31). **Carbon monoxide measurements in the Hiller FH-1100.**
March 1967.
By George L. Hody and Gerhard Y. Swidzinski.

(32). **Optical evaluation of a modified M-24 gas mask for flying personnel.**
April 1967.
By John K. Crosley.

Fiscal Year 1968

(33). **Comments on a proposed carbon monoxide sensing system for armed helicopters.**
July 1967.
By George L. Hody.

(34). **Task 051 consultant and commercial directory.**
August 1967.
(Author unknown.)

(35). **CO measurement in the armed LOH.**
September 1967.
By Gerhard Y. Swidzinski.

(36). **Survival kit, individual lightweight, Army FSN 84-65-J01-0741.**
September 1967.
By William P. Schane.

(37). **CH-47B lighting survey.**
October 1967.
By John K. Crosley.

(38). **CO measurement in the armed Cobra.**
October 1967.
By Gerhard Y. Swidzinski.

(39). **Downwash of the CH-47B.**
October 1967.
By William P. Schane.

(40). **Downwash of the CH-54A.**
October 1967.
By William P. Schane.

(41). **CO measurement in the CH-47A Chinook.**
November 1967.
By Gerhard Y. Swidzinski.

(42). **Impulse noise of the XM-27-E1 weapons system in the OH-6A helicopter.**
November 1967.
By Robert T. Camp, Jr.

(43). **Noise spectra of the U.S. Army CH-47B helicopter.**
November 1967.
By Robert T. Camp, Jr.

(44). **Impulse noise of the XM-41 weapons system in the CH-47A helicopter.**
December 1967.
By Robert T. Camp, Jr.

(45). **Noise spectra of the U.S. Army U-21A aircraft.**
December 1967.
By Robert T. Camp, Jr.

(46). **Recommended procedures for field anthropometry for accident reporting form ______.**
December 1967.
By Charles G. Moultrie and William P. Schane.

(47). **Evaluation of type 3R1 (64mm) optical insert for the M-24 aviator's CBR mask.**
January 1968.
By Robert W. Bailey.

(48). **Heat stress on AH-1G crews.**
February 1968.
By Delvin E. Littell.

(49). **Toxicological evaluation of 20mm gun.**
February 1968.
By Delvin E. Littell.

(50). **CO measurement of the Bell TH-13 helicopter heating system.**
March 1968.
By William P. Schane and Gerhard Y. Swidzinski.

(51). **Comparisons between three wind-tunnel configurations and the airflow field under a hovering helicopter.**
March 1968.
By William P. Schane.

(52). **Optimal sound pressure levels of low rpm audio warning signals in Army UH-1 helicopters.**
March 1968.
By Robert T. Camp, Jr.

(53). **The wearing of parachutes during helicopter flight.**
March 1968.
By William P. Schane.

(54). **Aeromedical considerations in air crash/rescue involving post-crash fires.**
April 1968.
By David B. Gillis and Arlie D. Price.

(55). **CO measurements of the Bell Cobra XM-28 weapons system.**
April 1968.
By William P. Schane and Gerhard Y. Swidzinski.

(56). **An evaluation of specially treated aviation maps viewed under ultraviolet light.**
April 1968.
By John K. Crosley.

(57). **Precautions necessary in instructor pilots engaged in aerial application of toxic materials.**
April 1968.
By William P. Schane.

(58). **Overall and octave-band noise attenuation characteristics of a soundproofing assembly in an Army OH-6A helicopter.**
May 1968.
By Robert T. Camp, Jr., and Igor Boris.

(59). **Preliminary observations of centrifugal tests of the sky hook litter system.**
May 1968.
By William P. Schane.

(60). **Carbon monoxide measurements of the XM-59 weapons system in the Bell UH-1D.**
June 1968.
By Brian L. Tiep and Gerhard Y. Swidzinski.

(61). **Mean body temperatures of OH-6A pilots during cold tests.**
June 1968.
By Delvin E. Littell and Lawrence Kelly.

(62). **Physical standards in HALO jumpers.**
June 1968.
By William P. Schane.

Fiscal Year 1969

(63). **Impulse noise of the XM-59 weapons system in a U.S. Army UH-1 helicopter.**
July 1968.
By Robert T. Camp, Jr.

(64). **Impulse noise of an XM-134 machine gun and an XM-129 grenade launcher in a U. S. Army AH-1G Huey Cobra helicopter.**
July 1968.
By Robert T. Camp, Jr.

(65). **Physical fitness program defined by Dr. Miller.**
July 1968.
By William P. Schane.

(66). **Ambient sound pressure levels of noise in Knox Field control tower, Fort Rucker, Alabama.**
August 1968.
By Robert T. Camp, Jr.

(67). **Calculated height-weight tables for Army aviators.**
September 1968.
By Delvin E. Littell and Lawrence Kelly.

(68). **Carbon monoxide measurements in the tethered trainer HT-1A.**
September 1968.
By Delvin E. Littell.

(69). **Comparison of heat stress of individuals wearing current flight suit and a new clothing system for Army aviators.**
September 1968.
By Delvin E. Littell and Lawrence Kelly.

(70). **Noise spectra of the US Army HT-1A tethered helicopter trainer.**
October 1968.
By Robert T. Camp, Jr.

(71). **Guillotine for the treatment of snakebite.**
November 1968.
By William P. Schane.

(72). **Overall and octave-band noise attenuation characteristics of soundproofing blankets in U.S. Army UH-1D helicopters.**
November 1968.
By Robert T. Camp, Jr.

(73). **A proposed helicopter ground crew helmet.**
December 1968.
By William P. Schane.

(74). **Comments concerning proposal No. 68-69 from Conrad Precision Industries for a Betalight.**
January 1969.
By Robert W. Bailey.

(75). **Carbon monoxide measurements in the AH-1G (Cobra) with XM-35 system.**
February 1969.
By Delvin E. Littell.

(76). **Carbon monoxide measurements in the OH-6A with XM-8 system.**
March 1969.
By Delvin E. Littell.

(77). **Impulse noise of an XM-8 subsystem on an U.S. OH-6 helicopter.**
March 1969.
By Robert T. Camp, Jr.

(78). **Report of analysis of carbon monoxide data obtained during missile firing test of M155 on 25 April 1969.**
May 1969.
By Delvin E. Littell and Donald T. Butts.

(79). **Carbon monoxide measurements in the OH-58A with XM-27E1 system.**
June 1969.
By Delvin E. Littell and Donald T. Butts.

(80). **Heat stress in airmobile aircraft maintenance shop.**
June 1969.
By Lawrence Kelly.

Fiscal Year 1970

(81). **Analysis of missile exhaust of 2.75 rocket system on AH-1G Cobra for carbon monoxide.**
September 1969.
By Donald T. Butts.

(82). **Comparison of heat stress of the AH-1G equipped with clear and tinted canopy.**
September 1969.
By Delvin E. Littell and Michael J. Maas.

(83). **An in-flight evaluation of liner temperatures of the SPH-4 and APH-5.**
September 1969.
By Delvin E. Littell.

(84). **Lighting survey of the LOH-58A (Kiowa).**
September 1969.
By John K. Crosley.

(85). **Medical and physiologic effects of ejection and parachuting, an overview.**
September 1969.
By Stanley C. Knapp.

(86). **Service test of the real-ear sound attenuation characteristics of the SPH-4 protective helmet.**
September 1969.
By Robert T. Camp, Jr.

(87). **Test of compatibility of chest parachute with UH-1D crew station and body armor.**
September 1969.
By Donald F. Miller.

(88). **Noise spectra of the US Army CH-47C helicopter.**
October 1969.
By Robert T. Camp, Jr.

(89). **Downwash of the CH-47C.**
November 1969.
By Delvin E. Littell.

(90). **Carbon monoxide measurements in the OH-58A helicopter with the heater in operation.**
December 1969.
By Delvin E. Littell.

(91). **Heat stress on OH-58A helicopter crews.**
December 1969.
By Delvin E. Littell.

(92). **Noise spectra of the U.S. Army OH-58A helicopter.**
December 1969.
By Robert T. Camp, Jr., Ronald F. Kovacs, and Donald C. Mappes.

(93). **Quality control test of the real-ear sound attenuation characteristics of the SPH-4 protective helmet, sample number 4, lot number 12.**
December 1969.
By Robert T. Camp, Jr.

(94). **Quality control test of the real-ear sound attenuation characteristics of the SPH-4 protective helmet, sample number 5, lot number 16.**
December 1969.
By Robert T. Camp, Jr.

(95). **Quality control test of the real-ear sound attenuation characteristics of the SPH-5 protective helmet, sample number 6, lot number 20.**
December 1969.
By Robert T. Camp, Jr.

(96). **Heat stress in an airmobile aircraft maintenance shop.**
January 1970.
By Delvin E. Littell.

(97). **Cold and heat stress on OH-58A helicopter crews.**
January 1970.
By David G. Schrunk and Michael J. Maas.

(98). **LOH-58A (Bell) canopy distortion survey.**
January 1970.
By John K. Crosley.

(99). **Quality control test of the real-ear attenuation characteristics of the SPH-4 protective helmet, sample number 7, lot number 24.**
January 1970.
By Robert T. Camp, Jr.

(100). **Polycarbonate helmet visor evaluation.**
February 1970.
By Robert W. Bailey.

(101). **Carbon monoxide measurements in the UH-1C with XM-140 gun.**
March 1970.
By Delvin E. Littell.

(102). **Impulse noise of a 30 millimeter XM-140 weapon on a U.S. Army UH-1C helicopter.**
March 1970.
By Robert T. Camp, Jr.

(103). **Magnesium fluoride coating of aviation spectacles.**
March 1970.
By Robert W. Bailey.

(104). **Octave band analysis of noise generated by an M-60 searchlight system in a U.S. Army UH-1 helicopter.**
March 1970.
By Robert T. Camp, Jr.

(105). **USAARL evaluation test report of life saving capabilities of the heliborne crash/rescue fire suppression system (CRFSS).**
April 1970.
By David G. Schrunk, Stanley C. Knapp, George R. McCahan, Jr., Robert McGowan, Brian Nemec, and Joseph Sadowski.

(106). **Noise spectra of a U.S. Army multiservice unit-1.**
April 1970.
By Robert T. Camp, Jr., Ronald F. Kovacs, and Donald C. Mappes.

(107). **Quality control test of the real-ear sound attenuation characteristics of the SPH-4 protective helmet, sample number 8, lot number 28.**
April 1970.
By Robert T. Camp, Jr.

(108). **Ambient sound pressure levels of noise in a U.S. Army AN/TSQ-71A landing control central.**
May 1970.
By Robert T. Camp, Jr., Michael J. Schaffner, and John E. Kenderdine.

(109). **An approach to local problems of vivarium design and construction.**
May 1970.
By George R. McCahan, Jr.

(110). **Lighting survey of the OV-1 (Mohawk).**
May 1970.
By John K. Crosley and William E. McLean.

(111). **Quality control test of the real-ear sound attenuation characteristics of the SPH-4 protective helmet, sample number 9, lot number 32.**
May 1970.
By Robert T. Camp, Jr., John E. Kenderdine, Jr., and Michael J. Schaffner.

(112). **Real-ear sound attenuation characteristics of three brands of ear protective devices proposed for armored vehicle crewmen.**
May 1970.
By Robert T. Camp, Jr.

Fiscal Year 1971

(113). **A field evaluation of a flash suppressor for the 7.62 minigun.**
July 1970.
By William E. McLean, John K. Crosley, and Robert W. Bailey.

(114). **Environmental cooling system evaluation in the OV-1-D Mohawk aircraft.**
September 1970.
By Leonard R. Kowalski.

(115). **Impulse noise of an XM-35 armament subsystem in an U.S. AH-1G Army Huey Cobra helicopter.**
October 1970.
By Robert T. Camp, Jr., John E. Kenderdine, Jr., and Michael J. Schaffner.

(116). **Hughes Forward Looking Infrared System (FLIR) evaluation.**
February 1971.
By Robert W. Bailey.

(117). **Evaluation of the sample Neodymium Visor No. V-156.**
December 1971.
By Robert W. Bailey.

71- 1-3- 1. **Medical aspects of the engineering and service test of standard air delivery equipment (personnel) at high drop zone elevations--USATECOM Project No. 8-EG-065-000-002/003.**
January 1971.
By Stanley C. Knapp and George R. McCahan, Jr.

71- 2-2- 1. **A comparative evaluation of two pairs of UH-1 chinbubbles (lower canopies) from different manufacturers.**
February 1971.
By John K. Crosley, Erwin B. Braun, Ronald G. Tabak, Edgar C. White, Jr., and Robert W. Bailey.

71- 3-3- 2. **The testing of thermal protective clothing in a reproducible fuel fire environment, Phase I report: A feasibility study.**
March 1971.
By Francis D. Albright, Francis S. Knox, III, David R. DuBois, and George M. Keiser.

71- 4-2- 2. **Noise spectra in and around a turbine test cell in Building 7206, Fort Rucker, Alabama.**
April 1971.
By Robert T. Camp, Jr., and Michael J. Schaffner.

71- 5-1- 1. **APE II - AH-56A helicopter.**
June 1971.
By Winton H. Burns, Calvin B. Lum, and George Volkov.

71- 6-2- 3. **Noise spectra of the U.S. Army OV-1D aircraft.**
June 1971.
By Robert T. Camp, Jr., Michael J. Schaffner, and John E. Kenderdine, Jr.

Fiscal Year 1972

72- 1-2- 1. **The effects of air inlet modifications on the sound spectra of U.S. Army CH-47C helicopter auxiliary power unit noise.**
July 1971.
By Robert T. Camp, Jr., Michael J. Schaffner, and John E. Kenderdine, Jr.

72- 2-2- 2. **Noise spectra of the Boeing-Vertol Model 347 helicopter.**
September 1971.
By Robert T. Camp, Jr., Michael J. Schaffner, and John E. Kenderdine, Jr.

72- 3-3- 1. **Determination of the maximum sitting height in U-10A aircraft.**
September 1971.
(Author unknown.)

72- 4-2- 3. **Impulse noise of one-half and one-quarter pound TNT charges when detonated in a corrugated steel drainage pipe.**
September 1971.
By Robert T. Camp, Jr.

72- 5-3- 2. **Determination of the maximum sitting height in a C-45 aircraft.**
September 1971.
By Thomas D. Casey.

72- 6-2- 4. **Internal/external lighting and canopy distortion survey of the AH-56A (Cheyenne) helicopter.**
September 1971.
By John K. Crosley and Erwin G. Braun.

72- 7-1- 1. **Evaluation of the cockpit thermal conditions of the synthetic flight training system 2B24.**
December 1971.
By William P. Schane.

72- 8-3- 3. **Preliminary findings and conclusions of the X-ray evaluation of the spinal alignment in human subjects while sitting in the improved MK-J5(D) ejection seat.**
January 1972.
By Burton H. Kaplan.

72- 9-2- 5. **Noise spectra of the synthetic flight training system Model 2B24.**
February 1972.
By Robert T. Camp, Jr., and Ben T. Mozo.

72-10-1- 2. **RDAT 1 SGS nystagmus-vertigo study.**
February 1972.
By Winton H. Burns and George Volkov, Jr.

72-11-1- 3. **Special tests on pilot and TOW missile system during APE III.**
February 1972.
By Robert W. Bailey and Winton H. Burns.

72-12-2- 6. **Real-ear attenuation characteristics of hearing protective devices available through federal supply channels.**
February 1972.
By Robert T. Camp, Jr., Ben T. Mozo, Lawrence F. Kuc, and Gordon A. Schott.

72-13-2- 7. **Thermal attenuation of the Army flight helmet sun visor.**
March 1972.
By John K. Crosley, Erwin G. Braun, and Ronald G. Tabak.

72-14-1- 4. **Stanford-Binet bibliography.**
April 1972.
By William P. Schane.

72-15-1- 5. **Wechsler bibliography.**
April 1972.
By William P. Schane.

72-16-3- 4. **Preliminary results, conclusions, and recommendations in reference to bump protection evaluation of the standard T56-6 and prototype DH-132 combat vehicle crewman's helmet.**
June 1972.
By Stanley C. Knapp, Thomas D. Casey, Burton H. Kaplan, and Donald G. Cheesman.

72-17-3- 5. **Preliminary results, conclusions, and recommendations from the evaluation of helmet flammability--DH-132 and T56-6 helmets.**
June 1972.
By Francis S. Knox, III.

72-18-2- 8. **A field of vision comparison of the standard U.S. Army Combat Vehicle Crewman (CVC) and the DH-132 protective helmets.**
June 1972.
By John K. Crosley and Lawrence J. Laychak.

72-19-2- 9. **Real-ear attenuation characteristics of a sample of DH-132 combat vehicle crewman helmets.**
June 1972.
By Robert T. Camp, Jr., Ben T. Mozo, Gordon A. Schott, and Lawrence F. Kuc.

Fiscal Year 1973

73- 1-2- 1. **An evaluation of anti-laser goggles: Fitting characteristics, field-of-view and effects upon color vision.**
August 1972.
By John K. Crosley, Lawrence J. Laychak, and Erwin G. Braun.

73- 2-2- 2. **Noise spectra in the Flight Simulation Division, Building 4901, Fort Rucker, Alabama.**
October 1972.
By Robert T. Camp, Jr., Ben T. Mozo, and Gordon A. Schott.

73- 3-3- 1. **Evaluation of U.S. Air Force personnel lowering devices integrated with the U.S. Army "Quick Fix" harness assembly for ejection seat aircraft.**
October 1972.
By Burton H. Kaplan.

73- 4-1- 1. **The effect of fiber and dye degradation products (FDP) on burn wound healing.**
December 1972.
By Francis S. Knox, III, Thomas L. Wachtel, George R. McCahan, Jr., Calvin B. Lum, and Walter P. Trevethan.

73- 5-2- 3. **Quality control test of the real-ear sound attenuation characteristics of SPH-4 protective helmet, sample number 10.**
January 1973.
By Robert T. Camp, Jr., Ben T. Mozo, Gordon A. Schott, Rohinton N. Guzdar, and Timothy M. Hinkel.

73- 6-3- 2. **Instrumented helicopter burn.**
January 1973.
By Calvin B. Lum.

73- 7-3- 3. **Evaluation of use of Velcro in place of zippers on Nomex flight suit.**
January 1973.
By Ernest B. Altekruse.

73- 8-1- 2. **Current cardiovascular and respiratory examination methods in medical selection and control of aircrews in the United States Army.**
March 1973.
By William P. Schane and Nicholas E. Barreca.

73- 9-3- 4. **Results, conclusions, and recommendations from the evaluation of helmet flammability--DH-132 and T56-6 helmets.**
May 1973.
By Francis S. Knox, III and Robert W. Bailey.

73-10-2- 4. **Sound pressure levels of noise from cooling fans outside of Building 4901, Fort Rucker, Alabama.**
May 1973.
By Robert T. Camp, Jr., Edward F. New III, and Alan L. Croshaw.

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74- 1-1- 1. **CO_2 measurement of the UH-1H XM-56 mine dispersing subsystem.**
July 1973.
By Steven K. Shults.

74- 2-3- 1. **Evaluation of the head cooling system.**
August 1973.
By Edward F. New III and Ernest B. Altekruse.

74- 3-3- 2. **Shock producing devices in survival training.**
August 1973.
By John C. Johnson and James P. Clark.

74- 4-2- 1. **Acoustic noise characteristics of the ARC-98 communication systems.**
August 1973.
By Robert T. Camp, Jr. and Ben T. Mozo.

74- 5-2- 2. **Sound pressure levels of the XM56 mine dispersing subsystem noise in a UH-1H helicopter.**
September 1973.
By Robert T. Camp, Jr., Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74- 6-1- 2. **Noxious gas measurement of missile ANSSR III--Program SEAS.**
October 1973.
By Steven K. Shults.

74- 7-2- 3. **Quality control test of the real-ear attenuation characteristics of SPH-4 protective helmets manufactured by Atkins and Merrill, pilot lot.**
December 1973.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74- 8-2- 4. **Quality control test of real-ear attenuation characteristics of SPH-4 protective helmets manufactured by American Safety Company, lot 2.**
December 1973.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74- 9-2- 5. **Quality control test of real-ear sound attenuation characteristics of SPH-4 protective helmets manufactured by American Safety Company, lot no. 3.**
December 1973.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-10-1- 3. **Low level versus nap-of-earth flying: EMG results.**
December 1973.
By Roger W. Wiley.

74-11-2- 6. **Acoustic evaluation of the AN/PRS-7 and AN/PSS-11 mine detectors and the AN/GSQ-151 anti-intrusion detectors.**
December 1973.
By James H. Patterson, Jr., Ben T. Mozo, Timothy M. Hinkel, and Rohinton N. Guzdar.

74-12-2- 7. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot no. 1.**
January 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-13-2- 8. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot no. 2.**
January 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-14-2- 9. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot no. 3.**
January 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-15-2-10. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot no. 4.**
January 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-16-2-11. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot no. 5.**
January 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-17-2-12. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lots 6, 7, 8, 9, 10, 11, and 12.**
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By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-18-2-13. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lots 13, 14, 15, 16, 17, 18, and 19.**
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By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-19-2-14. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lots 20, 21, 22, 23, and 24.**
February 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-20-2-15. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lots 25, 26, 27, 28, and 29.**
February 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-21-3- 3. **Evaluation of OH-58 seat belt support assembly.**
February 1974.
By Edward F. New III, Ernest B. Altekruse, Daniel Carpenter, and Richard A. Tucker.

74-22-2-16. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lots 30, 31, 32, 33, and 34.**
March 1974.
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74-23-2-17. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lots 35, 36, 37, 38, and 39.**
March 1974.
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74-24-2-18. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lots 40, 41, 42, 43, and 44.**
March 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-25-3- 4. **Study of lap belt installation in UH-1 armored seat.**
March 1974.
By Edward F. New III, Ernest B. Altekruse, and Daniel Carpenter.

74-26-2-19. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lots 45, 46, 47, 48, and 49.**
March 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-27-1- 4. **Respiratory effects of the individual survival vest, airman (ISVESTA).**
March 1974.
By Dennis A. Baeyens.

74-28-3- 5. **Evaluation of the impact protection provided by the parachutist helmet with and without protective nape pad.**
April 1974.
By Thomas D. Casey and Joseph L. Haley, Jr.

74-29-3- 6. **Crash injury analysis of OV-1D, Number 17018 fatal accident east of Dothan, Alabama, 22 February 1974.**
April 1974.
By Thomas D. Casey, Joseph L. Haley, Jr., Ernest B. Altekruse, and Stanley C. Knapp.

74-30-3- 7. **Preliminary evaluation of P/N 791 as combat vehicle crewman's helmet.**
April 1974.
By Joseph L. Haley, Jr., Stanley C. Knapp, and Robert K. Shirck.

74-31-2-20. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot 54.**
April 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Rohinton N. Guzdar, and Timothy M. Hinkel.

74-32-2-21. **Sound pressure levels of noise from cooling fans and pump room of Building 4901, Fort Rucker, Alabama.**
May 1974.
By Robert T. Camp, Jr.

74-33-1- 5. **Noxious gas measurements of missile ARROW.**
June 1974.
By Michael G. Medvesky.

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75- 1-7- 1. **Afterimage associated with using the AN/PVS-5, night vision goggles.**
August 1974.
By David D. Glick and Chris E. Moser.

75- 2-7- 2. **Dark adaptation changes associated with the use of AN/PVS-5 night vision goggles.**
August 1974.
By David D. Glick, Roger W. Wiley, Chris E. Moser, and Chun K. Park.

75- 3-1- 1. **Blood pressure and heart rate response to the application of the military antishock trouser in the intact human subject.**
August 1974.
By Frank S. Pettyjohn, Michael G. Medvesky, and Joseph O. Bonnet.

75- 4-2- 1. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot 59.**
August 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, and Harvey C. Brand.

75- 5-2- 4. **Investigation of a non-hardening seal for the DH-132.**
August 1974.
By Ben T. Mozo, Alan L. Croshaw, James H. Patterson, Jr., and Robert T. Camp, Jr.

75- 6-1- 2. **Forced landing area familiarization during preflight planning using airfield photographs.**
August 1974.
By David B. Anderson.

75- 7-2- 3. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot 64.**
August 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, and Harvey C. Brand.

75- 8-1- 3. **Aeromedical movement of the acute myocardial infarction.**
July 1974.
By Frank S. Pettyjohn.

75- 9-1- 4. **The incidence of equine infectious anemia in horses stabled on the Fort Rucker Army post.**
September 1974.
By Terry E. Gee and Neal Bonnett.

75-10-2- 2. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot 69.**
August 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, and Harvey C. Brand.

75-11-3- 1. **Comparison of the impact protection provided by the parachutist helmet with three different types of protective nape pads.**
August 1974.
By Joseph L. Haley, Jr.

75-12-2- 5. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot 74.**
August 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, and Harvey C. Brand.

75-13-1- 5. **Lactate dehydrogenase - Hyperbaric studies.**
August 1974.
By Dennis A. Baeyens.

75-14-2- 6. **Investigation of the effects of three types eyeglass temples on attenuation of the SPH-4 helmet.**
October 1974.
By Ben T. Mozo, Alan L. Croshaw, James H. Patterson, Jr., Robert T. Camp, Jr., Ron H. Marrow, and Harvey C. Brand.

75-15-2- 7. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot 79.**
November 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Harvey C. Brand, and Ron H. Marrow.

75-16-3- 2. **Second (bump) test evaluation of P/N 791 as combat vehicle crewman's helmet.**
November 1974.
By Joseph L. Haley, Jr., and Stanley C. Knapp.

75-17-7- 3. **Field of vision study with Sierra CVC helmet.**
November 1974.
By David D. Glick, Chris E. Moser, and Roger W. Wiley.

75-18-2- 8. **Real-ear sound attenuation characteristics of the modified Sierra P/N 791 CVC helmet.**
November 1974.
By Robert T. Camp, Jr., Alan L. Croshaw, James H. Patterson, Jr., Ben T. Mozo, and Harvey C. Brand.

75-19-4- 1. **Evaluation of the system interface characteristics of the synthetic flight training system (2B24).**
December 1974.
By Richard N. Armstrong and Lewis W. Stone.

75-20-4- 2. **Night vision system performance criteria.**
December 1974.
By Robert H. Wright.

75-21-7- 4. **Reduction of undesirable light reflections within the crew station of Army aircraft: Part I.**
December 1974.
By Franklin F. Holly.

75-22-1- 6. **Perception and problem solving under stress.**
January 1975.
By William P. Schane.

75-23-2- 9. **Quality control test of real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot 84.**
February 1975.
By Robert T. Camp, Jr., Alan L. Croshaw, Ben T. Mozo, Harvey C. Brand, and Ron H. Marrow.

75-24-7- 5. **The attenuation of light transmission in Army aircraft windscreens due to slanting.**
February 1975.
By Charles E. Moser.

75-25-2-10. **Investigation of a nonhardening ear pad for the SPH-4 helmet.**
May 1975.
By James H. Patterson, Jr., Ben T. Mozo, Alan L. Croshaw, Harvey C. Brand, Ron H. Marrow, and Robert T. Camp, Jr.

75-26-7- 6. **A visual comparison of standard and experimental maps using the AN/PVS-5 night vision goggles.**
March 1975.
By David D. Glick and Roger W. Wiley.

75-27-1- 7. **Aeromedical review of experimental high performance helicopter hoist.**
February 1975.
By Frank S. Pettyjohn, Terry E. Gee, Lloyd A. Akers, and Stephen A. Evans.

75-28-7- 7. **Quantitative analysis of waveform characteristics of pupillary reflex response to light in fatigue research.**
March 1975.
By Wun C. Chiou.

75-29-7- 8. **Visible spectral transmission characteristics of windscreens in Army aircraft.**
March 1975.
By Wun C. Chiou.

75-30-1- 8. **Techniques in phospholipid analysis.**
March 1975.
By David B. Anderson and Martha L. Pitts.

75-31-1- 9. **Vibration-induced osteoarthritis: An experimental approach and references.**
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By David B. Anderson and Roderick J. McNeil.

75-32-1-10. **Evaluation of the Puritan-Zep emergency O_2 mask.**
March 1975.
By Roderick J. McNeil and Frank S. Pettyjohn.

75-33-3- 3. **Survey of SPH-4 visor housing failures.**
March 1975.
By Ernest B. Altekruse.

75-34-7- 9. **Effects of geometrical configurations of quartz fiber optic bundles upon spectral transmission efficiency of coherent and incoherent radiation sources.**
April 1975.
By Wun C. Chiou.

75-35-1-11. **Idiopathic hypertrophic subaortic stenosis (IHSS) or asymmetric septal hypertrophy (ASH)--A review and case report.**
April 1975.
By Frank S. Pettyjohn.

75-36-7-10. **Comparative spectral studies of scratched (untreated) and polished (treated) UH-1 aircraft windscreens.**
April 1975.
By Wun C. Chiou.

75-37-1- 2. **Preoxygenation as a means of preventing decompression sickness in military aviation: A literature review.**
May 1975.
By Dennis A. Baeyens, Mary J. Meier, and Frank S. Pettyjohn.

75-38-7-11. **An experimental observation on coherent versus incoherent polarization.**
June 1975.
By Wun C. Chiou.

75-39-2-11. **DSA100-72-C-0143, lot 9 real-ear sound attenuation performance and limited production/purchase description 53-70 comparison.**
June 1975.
By Alan L. Croshaw, Harvey C. Brand, Claude E. Hargett, Jr., and Robert T. Camp, Jr.

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76- 1-7- 1. **Synthetic spectra.**
August 1975.
By Wun C. Chiou.

76-02-7- 2. **Infrared power spectral and transmission characteristics of windscreens in Army aircraft.**
August 1975.
By Wun C. Chiou.

76- 3-1- 1. **Aeromedical consideration in the use of pneumatic splints in rotary- and fixed-wing aircraft.**
August 1975.
By Frank S. Pettyjohn, Lloyd A. Akers, George P. Rice, and Micaela Gargano.

76- 4-7- 3. **Effect of external paint color on cockpit interior temperature.**
August 1975.
By Wun C. Chiou.

76- 5-7- 4. **Photometric measurement of chemiluminescence - Cyalume .**
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By Wun C. Chiou and Danny N. Price.

76- 6-1- 2. **An abbreviated anthropometric survey to confirm seat specifications for the advanced scout helicopter.**
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By William P. Schane.

76- 7-1- 3. **Evaluation of aeromedical evacuation equipment Vital 1 pulse monitor.**
September 1975.
By Frank S. Pettyjohn and George P. Rice.

76- 8-1- 4. **Aeromedical evaluation of medsonics ultrasound stethoscope, model B4FA.**
October 1975.
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76- 9-3- 1. **The effects of interior coloration on thermal loading in Army aircraft.**
October 1975.
By J. Christopher Johnson and Mark S. Blackmore.

76-10-2- 1. **Real-ear sound attenuation characteristics of DH-132 helmets manufactured by Gentex Corporation, lot 1.**
November 1975.
By Robert T. Camp, Jr., Alan L. Croshaw, and Ben T. Mozo.

76-11-1- 5. **Preliminary report: Aeromedical evaluation UH-1 internal personnel rescue hoists - Western Gear hoist model numbers 42277R1 and 42305R1.**
December 1975.
By Frank S. Pettyjohn, Lloyd A. Akers, and George P. Rice.

76-12-2- 2. **Comparison of sound pressure levels produced by two types of engines in the OH-58 helicopter.**
January 1976.
By Ben T. Mozo and Robert T. Camp, Jr.

76-13-7- 5. **Visible spectral transmission characteristics of windscreens in Army aircraft: Part II.**
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By Wun C. Chiou.

76-14-7- 6. **A comparison of the reflective properties of an IR acrylic base paint and Nextel Velvet Coating 101-C10.**
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By Franklin F. Holly, Roger W. Wiley, and David D. Glick.

76-15-2- 3. **Real-ear sound attenuation characteristics and impact (bump) tests evaluation of the proposed final modification of the Sierra P/N 791 AVC helmet.**
February 1976.
By William R. Nelson, James H. Patterson, Jr., Pierre Allemond, Robert W. Bailey, and Robert T. Camp, Jr.

76-16-7- 7. **Infrared power and transmission characteristics of windscreens in Army aircraft: Part II.**
January 1976.
By Wun C. Chiou.

76-17-3- 2. **Analysis of SPH-4 helmet performance from 1972-1975.**
Undated.
By Bruce A. Slobodnik, Joseph L. Haley, Jr., and James H. Patterson, Jr.

76-18-2- 4. **Noise levels in the AH-1Q equipped with a low glare (flat plate) canopy.**
April 1976.
By Ben T. Mozo and Robert T. Camp, Jr.

76-19-2- 5. **Preliminary medical evaluation of the acoustic hazard from the Weaponeer Rifle Simulator.**
June 1976.
By James H. Patterson, Jr., Ben T. Mozo, and Robert T. Camp, Jr.

76-20-1- 6. **Aeromedical evaluation UH-1 internal personnel rescue hoists, Breeze ECP-720 modifications.**
September 1976.
By Frank S. Pettyjohn, Lloyd A. Akers, George P. Rice, Pierre Allemond, Stephen M. Bailey, Raymond T. Burden, William F. Carroll, and Thomas G. Harrison.

76-21-1- 7. **Aircrew requirements for day/night and surge operations.**
September 1976.
By William P. Schane and Michael G. Sanders.

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77- 1-7- 1. **Utilization of existing aircraft landing light as an artificial illumination source for AN/PVS-5, night vision goggles training.**
October 1976.
By Wun C. Chiou.

77- 2-1- 1. **Biomedical study of military antishock trousers in the normovolemic and hypovolemic dog.**
November 1976.
By Frank S. Pettyjohn and Lloyd A. Akers.

77- 3-2- 1. **Noise levels measured in a AH-1S equipped with a low glare, slightly curved canopy.**
January 1977.
By Ben T. Mozo and Robert T. Camp, Jr.

77- 4-2- 2. **Investigation of the effects of one standard and two experimental eyeglass temples on sound attenuation of the SPH-4 helmet.**
January 1977.
By William R. Nelson, Claude E. Hargett, Jr., Ron H. Marrow. and Robert T. Camp, Jr.

77- 5-2- 3. **Real-ear sound attenuation characteristics of the Labaire ear protector.**
February 1977.
By Robert T. Camp, Jr., and William R. Nelson.

77- 6-4- 1. **Human factors evaluation of the 214A helicopter.**
April 1977.
By Richard N. Armstrong, Ronald R. Simmons, Gerald P. Krueger, and Raymond Burden.

77- 7-7- 2. **Night vision goggle, AN/PVS-5, modification for daytime training.**
June 1977.
By Isaac Behar.

77- 8-7- 3. **Lighting evaluation of the Bell 214A helicopter.**
June 1977.
By Franklin F. Holly.

77- 9-7- 4. **Ambient light characteristics of a modified AN/VSS-4 (XE-4) search light system and a Fire Fly light system (FFLS).**
June 1977.
By Wun C. Chiou.

77-10-7- 5. **Visual selection criteria for armored vehicle crewmen.**
June 1977.
By John K. Crosley, Roger W. Wiley, Carol T. Bucha, and Hal Chaikin.

77-11-7- 6. **Lighting evaluation of the YUH-60A helicopter and the YUH-61A helicopter.**
September 1977.
By Franklin F. Holly and Wun C. Chiou.

77-12-4- 2. **Human factors evaluation of the AH-1S production helicopter.**
September 1977.
By Richard N. Armstrong and James L. Wofford.

77-13-1- 2. **Saturated heat oxygen/bleed-air nebulizer for resuscitation of hypothermic casualties in air evacuation.**
July 1977.
By Frank S. Pettyjohn, Joseph C. Denniston, Gary D. Pollard, John C. Kelliher, Lloyd A. Akers, and Charles F. Piper.

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78- 1-7- 1. **Optical evaluation of the AH-1S slightly bowed canopy.**
October 1977.
By Franklin F. Holly, Isaac Behar, David D. Glick, and Wun C. Chiou.

78- 2-2- 1. **Noise levels measured in the first run production models of the AH-1S Cobra helicopter.**
October 1977.
By Ben T. Mozo and Robert T. Camp, Jr.

78- 3-7- 2. **High intensity illumination evaluation on the terrain model board light bank of the CH-47 synthetic flight training system (SFTS).**
November 1977.
By Wun C. Chiou.

78- 4-4- 1. **Human factors evaluation of the CH-47C synthetic flight training system (2B31).**
November 1977.
By Richard N. Armstrong, John H. Sapp, and Gerald P. Krueger.

78- 5-7- 3. **Optical characteristics and distortion evaluation of UTTAS aircraft YUH-60A and YUH-61A windscreen transparencies.**
November 1977.
By Wun C. Chiou.

78- 6-7- 4. **Night vision goggle training in the 2B31 synthetic flight training simulator.**
November 1977.
By Isaac Behar.

78- 7-3- 1. **After-wear impact evaluation of the personnel armor systems for ground troops (PASGT) helmets.**
January 1978.
By John D. Current.

78- 8-8- 1. **Army aeromedical evaluation of the *United Kingdom prototype aircrew* NBC defense assembly.**
December 1977.
By Raymond T. Burden, Jr.

78- 9-3- 2. **Evaluation and comparison of the center of gravity location of the PASGT and M-1 infantry helmets.**
December 1977.
By Ted A. Hundley.

78-10-7- 5. **Head aiming/tracking accuracy in a helicopter environment.**
March 1978.
By Robert W. Verona.

78-11-1- 1. **Toxic gas analysis evaluation of the Casey heater.**
March 1978.
By Gary D. Pollard, Charles F. Piper, and Joseph C. Denniston.

78-12-1- 2. **Evaluation of exhaust contamination of the CH-54 troop carrying POD during airborne operations.**
April 1978.
By Gary D. Pollard, Bruce F. Hiott, and Joseph C. Denniston.

78-13-2- 2. **Internal noise characteristics of a U.S. Army C-12A aircraft.**
April 1978.
By Robert T. Camp, Jr., and Ron H. Marrow.

78-14-1- 3. **Design and installation of an oxygen system for use in the CH-47.**
May 1978.
By Bruce F. Hiott, Charles F. Piper, and Joseph C. Denniston.

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78-16-7- 6. **Field-of-view and windscreen distortion test of flat-plate observation helicopter canopy (OH-58C).**
June 1978.
By Wun C. Chiou.

78-17-7- 7. **Contrast enhancing eye shields for daytime training with night vision goggles, AN/PVS-5.**
June 1978.
By Isaac Behar.

78-18-7- 8. **Goniophotometric evaluation of landing light diffusers for night vision goggle training.**
June 1978.
By Isaac Behar.

78-19-2- 3. **The modification of the AN/PRC-70 transceiver.**
July 1978.
By Robert T. Camp, Jr.

78-20-2- 4. **Sound pressure levels produced by an ALQ-144 infrared suppressor.**
September 1978.
By Ben T. Mozo, Ron H. Marrow, and Robert T. Camp, Jr.

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79- 1-3- 1. **Visual performance criteria to define specific requirements for the U.S. Army Research and Technology Laboratories' (USARTL) helicopter simulator- (Helicopter flight imagery: Eye and head movement).**
January 1979.
By Ronald R. Simmons, Michael W. Melton, and Kent A. Kimball.

79- 2-3- 2. **An evaluation of the lighting of the tactical air traffic control tower (TSW-7) for blackout and night vision goggle compatibility.**
January 1979.
By Gerald P. Krueger, Franklin F. Holly, and Ronald R. Cisco.

79- 3-3- 3. **Bio-optic and human factors evaluation of the OH-58C helicopter with improved flat plate canopy.**
January 1979.
By Gerald P. Krueger, Richard N. Armstrong, Wun C. Chiou, Franklin F. Holly, and David D. Glick.

79- 4-2- 1. **Preliminary evaluation of the Hewlett-Packard ear oximeter in Army aircraft.**
March 1979.
By Jeffrey K. Kessler.

79- 5-5- 1. **Evaluation of toxic gases in the cockpit of the OH-58C.**
May 1979.
By Gary D. Pollard, Jonathan P. Stroud, and Timothy L. Hargrove.

79- 6-3- 4. **Operational evaluation of cattlehide leather/Nomex flyers gloves.**
May 1979.
By Gerald P. Krueger, Jonathan P. Stroud, and Gerald L. Johnson.

79- 7-2- 2. **Bio-optic evaluation of UH-1H armor windshield.**
June 1979.
By Isaac Behar and Franklin F. Holly.

79- 8-2- 3. **Acoustic evaluation of the AN/APR-39 radar warning detector.**
June 1979.
By Ben T. Mozo.

79- 9-1- 1. **Viper exhaust burn hazard.**
June 1979.
By Francis S. Knox, III.

79-10-2- 4. **Real-ear sound attenuation measurements on Bilsom Propp-O-Plast----a disposable hearing protection device.**
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By Jerod L. Goldstein.

79-11-2- 5. **Characteristics of headsets used with DRIMS systems.**
September 1979.
By Ben T. Mozo and Ron H. Marrow.

79-12-3- 5. **Human factors evaluation of the AH-1 Cobra attack helicopter synthetic flight training system, device 2B33.**
September 1979.
By Gerald P. Krueger, Ronald R. Cisco, Ben T. Mozo, Jerod L. Goldstein, and Franklin F. Holly.

79-13-3- 6. **Human factors in aviation safety: Psychology, medicine and engineering.**
September 1979.
By Gerald P. Krueger.

Fiscal Year 1980

80- 1-3- 1. **Mathematical formulation and computer analysis of minimization of cockpit reflections.**
January 1980.
By William S. Brownell, Franklin F. Holly, and Wun C. Chiou.

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December 1979.
By Franklin F. Holly.

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December 1979.
By William R. Holt.

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By Franklin F. Holly.

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April 1980.
By Lawrence R. Whitehurst.

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By Jonathan P. Stroud and Robert R. Barr.

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By Ted A. Hundley.

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August 1980.
By Ben T. Mozo, Barbara Murphy, and Ron H. Marrow.

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September 1980.
By Bruce F. Hiott, Ted A. Hundley, and Gerald L. Johnson.

Fiscal Year 1981

81- 1-2- 1. **Effects of reduced combiner transmission in the integrated helmet and display sighting system.**
January 1981.
By Clarence E. Rash, William E. McLean, and Daniel R. Monroe.

81- 2-4- 1. **Medical design criteria for U.S. Army motorcyclist's helmet.**
January 1981.
By Ted A. Hundley, Joseph L. Haley, Jr., and Dennis F. Shanahan.

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March 1981.
By Ben T. Mozo.

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By Ben T. Mozo.

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By Doris M. Hirsch and Thomas E. Erhardt.

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April 1981.
By James H. Patterson, Jr., Ben T. Mozo, and Robert T. Camp, Jr.

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May 1981.
By Clarence E. Rash, William E. McLean, and Daniel R. Monroe.

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June 1981.
By Franklin F. Holly, Daniel R. Monroe, and Clarence E. Rash.

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August 1981.
By Robert T. Camp, Jr., Mary C. Duchene, and Ben T. Mozo.

81-10-2- 9. **Evaluation of two parachutists' helmets.**
September 1981.
By Jerod L. Goldstein.

Fiscal Year 1982

82- 1-5- 1. **Sample surveys--principal steps in sample surveys.**
January 1982.
By William R. Holt.

82- 2-5- 2. **Tables of random digits.**
February 1982.
By William R. Holt and Mildred R. Faison.

82- 3-4- 1. **Biomedical assessment of the high survivability test vehicle (lightweight).**
February 1982.
By John C. Johnson, Isaac Behar, Jeffrey B. Kessler, John H. Wells, and Stanley C. Knapp.

82- 4-5- 3. **SPH-4 aviator helmet electronic tester.**
March 1982.
By Donald C. Schneider.

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March 1982.
By William R. Holt.

82- 6-2- 1. **Prototype testing of the integrated helmet unit for the integrated helmet and display sighting system.**
April 1982.
By Clarence E. Rash, Joseph L. Haley, Jr., Ted A. Hundley, William E. McLean, and Ben T. Mozo.

82- 7-3- 1. **Survey for toxic contaminants in the Blackhawk helicopter during Hellfire missile launches.**
August 1982.
By William A. Chaffin, Jr., and Richard M. Weber.

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August 1982.
By William E. McLean.

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September 1982.
By John F. Staples.

Fiscal Year 1983

83- 1-5- 1. **Statistical interim report: Statistical comparison of vibration regimen between a standard and a German helicopter seat for humans.**
September 1982.
By William R. Holt and John H. Wells.

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By Clarence E. Rash, John S. Martin, and William E. McLean.

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By William R. Holt.

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May 1983.
By Clarence E. Rash, Elizabeth A. Vereen, and William E. McLean.

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June 1983.
By James M. Conner and John H. Wells.

83- 6-2- 3. **Standard operation and alignment of Zeiss EM10C electron microscope.**
April 1983.
By Jim E. Fulbrook, Martha E. Verchot, and David L. Lentz.

83- 7-2- 4. **Options in operation and maintenance procedures for the Zeiss EM10C electron microscope.**
May 1983.
By Martha E. Verchot, Jim E. Fulbrook, and David L. Lentz.

83- 8-2- 5. **Light level calendars of lunar illumination at Fort Rucker, Alabama for July-December 1983.**
July 1983.
By Clarence E. Rash.

83- 9-2- 6. **Visual and optical evaluations of the XM-40 protective mask.**
August 1983.
By Clarence E. Rash and William E. McLean.

83-10-2- 7. (FOUO) **Visual and optical evaluations of the British S-10 respirator.**
August 1983.
By William E. McLean and Clarence E. Rash.

83-11-5- 3. **Statistical interim report: Some experimental design considerations for an investigation on neck muscle stress/endurance in helicopter pilots.**
September 1983.
By William R. Holt.

Fiscal Year 1984

84- 1-2- 1. **Light level calendars of lunar illumination at Fort Rucker, Alabama for January-June 1984.**
March 1984.
By Clarence E. Rash and Elizabeth A. Vereen.

84- 2-3- 1. **Assessment of stress descriptors for aeromedical research.**
March 1984.
By George D. Siering.

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March 1984.
By William A. Chaffin, Jr., Francis S. Knox, III, and Philip L. Taylor.

84- 4-3- 3. (USGO) **Comparative assessment of the U.S. MBU-12/P and the British P/Q oxygen masks.**
June 1984.
By William A. Chaffin, Jr.

84- 5-3- 4. **Concept evaluation of Bell Helicopter-Textron micro-heads-up display for night vision goggles.**
March 1984.
By Bruce E. Hamilton, A. Scott Wells, and Ronald R. Simmons.

84- 6-2- 2. **Light level calendars of lunar illumination at Fort Rucker, Alabama for July-December 1984.**
July 1984.
By Clarence E. Rash, Katheryn N. Price, and Elizabeth A. Vereen.

84- 7-2- 3. **Production item testing of the integrated helmet unit for the integrated helmet and display sighting system.**
September 1984.
By Clarence E. Rash, Joseph L. Haley, Jr., William E. McLean, and Ben T. Mozo.

Fiscal Year 1985

85- 1-4- 1. **Final evaluation of the standard infantry helmet for use as an Army motorcycle helmet.**
October 1984.
By B. Joseph McEntire and Joseph L. Haley, Jr.

85- 2-2- 1. (FOUO) **Visual and optical evaluations of the British S-10 (Modified) respirator.**
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By Clarence E. Rash and William E. McLean.

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November 1984.
By Clarence E. Rash, Ben T. Mozo, William E. McLean, Barbara A. Murphy, Elizabeth A. Vereen, and Katheryn N. Price.

85- 4-2- 3. **Visual and optical evaluations of the engineering design test prototypes of the XM-40 CB mask.**
November 1984.
By William E. McLean and Clarence E. Rash.

85- 5-2- 4. **Light level calendars of lunar illumination at Fort Rucker, Alabama for January-June 1985.**
January 1985.
By Clarence E. Rash and Elizabeth A. Vereen.

85- 5-5- 1. **Gunner recoil response to 75mm and 105mm cannons mounted on the light armored vehicle (LAV) chassis.**
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By Donald C. Schneider, Jr., and J. Alan Lewis.

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June 1985.
By Clarence E. Rash and Elizabeth A. Vereen.

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September 1985.
By Clarence E. Rash and John K. Crosley.

85- 9-2- 6. **Visual and optical evaluations of the US-10 respirator (DT II).**
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By Clarence E. Rash and John K. Crosley.

85-10-4- 2. **Blind flight using auditory displays in conjunction with a simulated voice-interactive system.**
September 1985.
By George R. Mastroianni.

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September 1985.
By William E. McLean and Clarence E. Rash.

85-12-3- 2. **Potential health hazard of the light helicopter experimental (LHX) cockpit design.**
September 1985.
By Douglas E. Landon.

Fiscal Year 1986

86- 1-3- 1. **Potential health hazard issues for the light helicopter experimental (LHX) initial health hazard assessment.**
December 1985.
By Scott Wells, Douglas Landon, Barclay P. Butler, Clarence E. Rash, William R. Nelson, and Joseph L. Haley, Jr.

86- 2-2- 1. **Light level calendars of lunar illumination at Fort Rucker, Alabama for January-June 1986.**
January 1986.
By Clarence E. Rash and Elizabeth A. Vereen.

86- 3-3- 2. **Integrated concept for physiology, psychology, and performance.**
February 1986.
By Glenn W. Mitchell.

86- 4-2- 2. **Operation and maintenance of the Zeiss videoplan image analysis system.**
March 1986.
By Jim E. Fulbrook and Geraldine Fields.

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April 1986.
By R. Fred Rolsten, Ronald S. Williams, and Joseph L. Haley, Jr.

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April 1986.
By Barclay P. Butler and Roy E. Maday.

86- 7-3- 3. **Determination of space requirements for medical tasks on medevac aircraft.**
August 1986.
By Glenn W. Mitchell and A. Scott Wells.

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August 1986.
By Clarence E. Rash, Elizabeth A. Vereen, and John S. Martin.

86- 9-4- 3. **Effect of the XM-43 mask with the integrated helmet and display sighting system on field-of-view.**
September 1986.
By Daniel W. Gower, Jr.

Fiscal Year 1987

87- 1-4- 1. **Health hazard issues in the helmet integrated display and sighting system (HIDSS) for the light helicopter experimental (LHX).**
November 1986.
By Biodynamics Research Division.

87- 2-2- 1. **An investigation of prismatic deviation measurement techniques.**
December 1986.
By Clarence E. Rash and John S. Martin.

87- 3-2- 2. **Light level calendars of lunar illumination at Fort Rucker, Alabama for January-December 1987.**
January 1987.
By Clarence E. Rash and John S. Martin.

87- 4-2- 3. **Visual performance with the AH-64 protective mask.**
January 1987.
By David J. Walsh, Clarence E. Rash, and Isaac Behar.

87- 5-3- 1. **Determination of maximum litter capacity for utility version of the light helicopter, experimental (LHX) aircraft system.**
February 1987.
By Alexander S. Wells and Glenn W. Mitchell.

87- 6-4- 2. **Whole-body vibration analysis for the Army Helicopter Improvement Program (AHIP) on the OH-58D Scout helicopter.**
February 1987.
By Roy Maday and Barclay Butler.

87- 7-2- 4. **Testing of the prototype extra-large integrated helmet unit for the integrated helmet and display sighting system (IHADSS).**
March 1987.
By Clarence E. Rash, John S. Martin, Ben T. Mozo, and Joseph L. Haley, Jr.

87- 8-4- 3. **Initial considerations in the characterization of terrain surface roughness.**
May 1987.
By Barclay P. Butler and John F. Schmeelk.

87- 9-4- 5. **Whole-body vibration exposure to crewmembers of the counterobstacle vehicle.**
September 1987.
By Barclay P.Butler and Roy E. Maday.

87-10-2- 5. **The effect of the M-43 chemical protective mask on the field-of-view of the helmet display unit of the Integrated Helmet Display and Sighting System.**
August 1987.
By Clarence E. Rash and John S. Martin.

87-11-5- 1. **Aviation epidemiology data register software design.**
September 1987.
By Heber D. Jones

87-12-4- 5. **Effects of helmet weight and center-of-gravity parameters on head tracking performance in a vibration environment.**
August 1987.
By Barclay P. Butler, Roy E. Maday, and Deborah M. Blanchard.

87-13-2- 6. **Noise levels measured in the UH-60A when firing the Hellfire missile.**
September 1987.
By Ben T. Mozo and Elmaree Gordon.

Section E

Authors' index for letter reports.

= D =

= E =

= M =

= Mc =

= N =

= O =

= P =

Wright, Robert H.
75-20- 4- 2.

= **Z** =

Zimmet, Sidney
(24).

Section F

Subject index for letter reports.

= A =

= B =

= C =

= D =

= E =

= F =

= G =

= H =

= I =

= L =

= M =

= O =

= P =

= R =

= V =

= W =

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